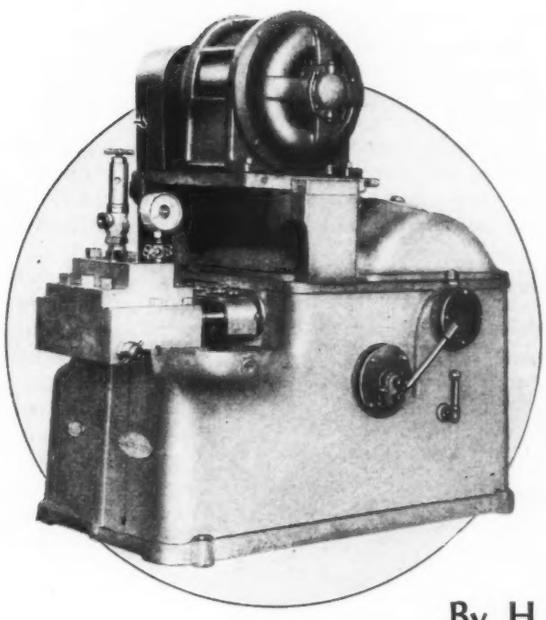
PRODUCT ENGINEERING

A McGRAW-HILL PUBLICATION

New York, September, 1930



WHERE MATERIALS COUNT

By H. S. FIELDER

Cherry-Burrell Corporation

High Pressure and Corrosion-Resistance Are Important in The Viscolizer

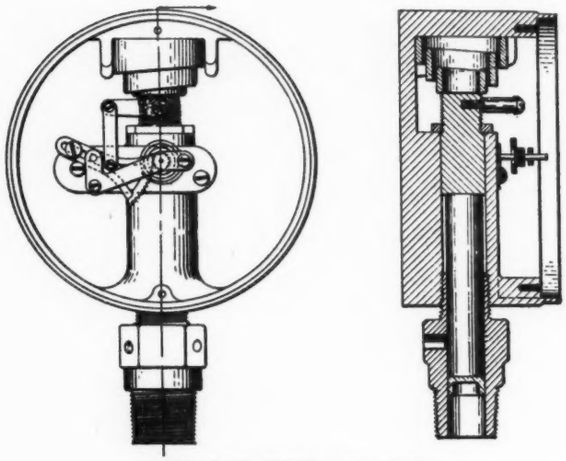
RESEARCH in the manipulation of modern food products has called out hundreds of specially designed and ingeniously fabricated machines for the preparation of packaged foods which the modern standard of living demands for convenience. Among these machines an interesting example is the Viscolizer, designed and constructed for effecting hitherto impossible and improving already existing emulsions in the food, the beverage, and the chemical fields.

Two problems were of outstanding importance among the considerations affecting the design of the Viscolizer, namely, corrosion- and acid-resistance because of the contact with many kinds of food products; and the high pressure required in the flow of the liquid mixtures to be smoothed or "viscolized." This machine is employed in a wide variety of food industries for blending and smoothing milk products, cream, tomato juice, salad dressings, and other similar products. It is also used for blending fine paints. It is highly important that no metallic contamination of these products occurs while they are passing through the machine, and the problem is aggravated by the high presure at which the liquids flow through the cylinders and valves. Only by the most careful selection of construction materials was it possible

to arrive at the results desired in the various products.

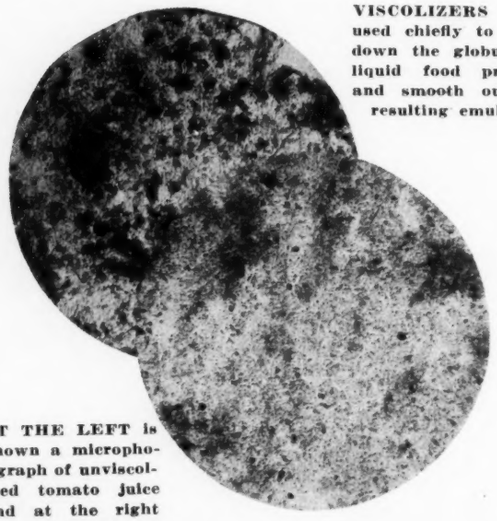
The action of the Viscolizer is simple. A plunger pump draws in the liquid to be "viscolized" and forces it at high pressure, 2,000 to 3,000 lb. per sq.in., through a valve the plunger of which is gaged with a heavy spring to permit a very fine passage for the liquid, usually only a few thousands of an inch. The calculated maximum velocity of the liquid through the narrow section of the valve is estimated to be about 25,000 ft. per sec., and the valve actually seats and unseats at a high frequency. The passing of the liquid through the valve breaks up and disperses the globules, making the liquid thoroughly homogeneous.

The main shaft on the drive end of the machine is stationary, and is held fast at each end by heavy setscrews in the cast-iron frame of the machine. The cam block, which consists of three eccentric cams and a hub to take the drive gear, is machined out of a solid steel billet and bored for two long bearing bushings which are of leaded bearing bronze and pressed into ends of the block. The cams are cut as close together as possible without spacers or collars between in order to keep the plungers together for cylinder compactness. The cast-iron drive gear is pressed and keyed on the hub of the cam block. The stationary shaft has an oil hole drilled in the center with grooves to permit oil from the lubricating pump to be forced between the bronze bushings and through the cams to their bearings surfaces. The eccentrics are gray-iron castings.



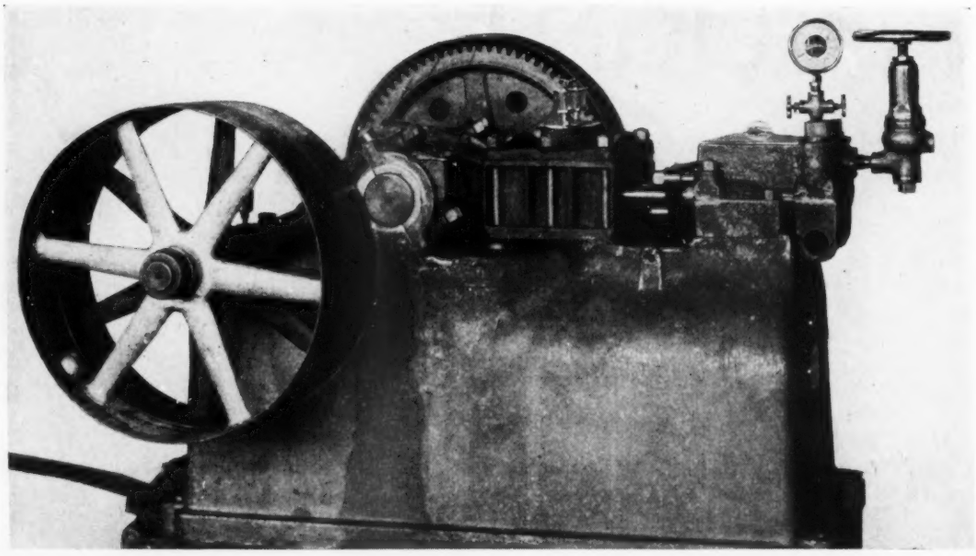
HIGH-PRESSURE gage shown in cross-section. A direct measure of the pressure of the liquid is obtained through adjustable needle valves

No food products, of course, come into contact with parts of the drive end of the machine, and these parts need therefore be designed for strength and wear only. But it is considered important that the machine should give continuous service over a long period of time even in the hands of operators who are not mechanics. Besides the positive pressure lubrication from the oil pump at the points of high pressure on the cam block bushings, a "running in oil" system of lubrication is used. The heavy oil from the reservoir under the shaft is carried up by the drive gear and is guided onto the cover of the crosshead and thence back over crossheads and eccentrics into the reservoir. So positive is this stream of oil in its flow that no glands or stuffing boxes are required on the plungers. For added security, however, a bronze or a hard rubber ring is located on each plunger to keep any drops of oil from reaching the end of the machine where the food products are handled. The crossheads, which are gray-iron castings, are set close together, and take the thrust at the bottom, the cast-iron cover plate serving only to guide the lubricating oil. A heavy setscrew,



VISCOLIZERS are used chiefly to break down the globules of liquid food products and smooth out the resulting emulsion

AT THE LEFT is shown a microphotograph of unviscolized tomato juice and at the right the same substance viscolized at 3,000-lb.-per-sq.in. pressure



THE NEW Viscolizer was evolved from a pulley-driven machine of conventional design. The small types retain some of these features, but a comparison of this machine with the new one in the headpiece will show the progress

placed at an angle, holds the plunger to the crosshead, the shoulder on the plunger taking all of the thrust.

The driving motor is placed on top of the machine to conserve space, and gives a speed of 100 r.p.m. to the cam block. The drive from the motor to the pinion shaft is by means of either a silent chain or V-belt drive.

The cylinders are machined from a chromium stainless-steel block. The three cylinder valve ports and manifold are bored from the solid billet to obviate any danger of holes or flaws in a casting. The block is keyed to the frame to take the thrust and bolted through the flanges.

The plungers are of a hard grade of Allegheny metal ground to a highly-polished surface, and pass through screw-type bronze packing glands, as shown in an accompanying illustration. Between the bronze plunger throat and the bronze gland is a special packing, suitable for the type of food product to be handled. For ordinary applications a cup leather packing of chrome leather is used with a rubber impregnated canvas spacer. This type of packing will hug the plunger tightly only on the compression stroke, and is very effective, but cannot be used where products are being passed through the machine at temperatures above 180 deg. F. Such prepared packings as Garlock, Anchor, and Victor, made up of compositions and in special shapes, are used to meet special conditions of temperature and food product. Because of the variety of conditions it is impossible to standardize.

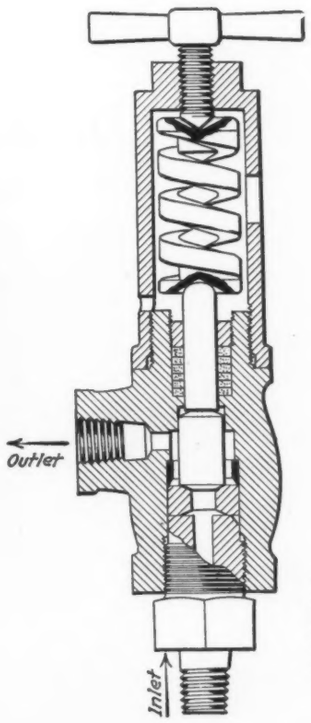
Water is the only lubricant used on the plungers, and is dropped in from a commercial type of pet cock as shown in the illustration. Inlet and exhaust valve openings are of the same size. The valve seats are pressed into the block, and are of a very hard grade of Allegheny metal which is proof against corrosion by the commonly handled food products and will resist erosion from the high velocity of flow of the liquids. They are made easily removable for replacement. The valves are of "bell metal" with a very high tin content, and are seated by coil springs of stainless steel wire. The valve guide blades are curved in order to obtain a slight rotary motion of the valve. The plugs and spacers are of Monel metal. In ordinary pump practice the conventional plugs are fitted with the washer type of gaskets, but in this design a molded rubber gasket is seated between the spacer and the plug. This construction prevents the liquid from seeping into the plug thread. Where the product is of such a nature as to affect the rubber, a pure tin gasket is used. In adapting the machine to the handling of such varying products as mllk, tomato juice, floor wax, and oil paints, the problem of materials selection for the parts is always uppermost in the mind of the designers, and the materials have to be varied to meet any unusual corrosion conditions, corrosion tests being made when there is any doubt as to the suitability of the material.

IN EVERY line of industry machinery is being replaced, not because it is worn out, but because it has become obsolete through development and improvement. In the cause of human betterment it is the work of the designing engineer to seek greater mechanical efficiency—to improve—to conserve both manpower and natural resources. In doing this the cause of progress is carried forward. It is in this spirit that the engineers of the Cherry-Burrell Corporation strive to make every product better than anything that has gone before.

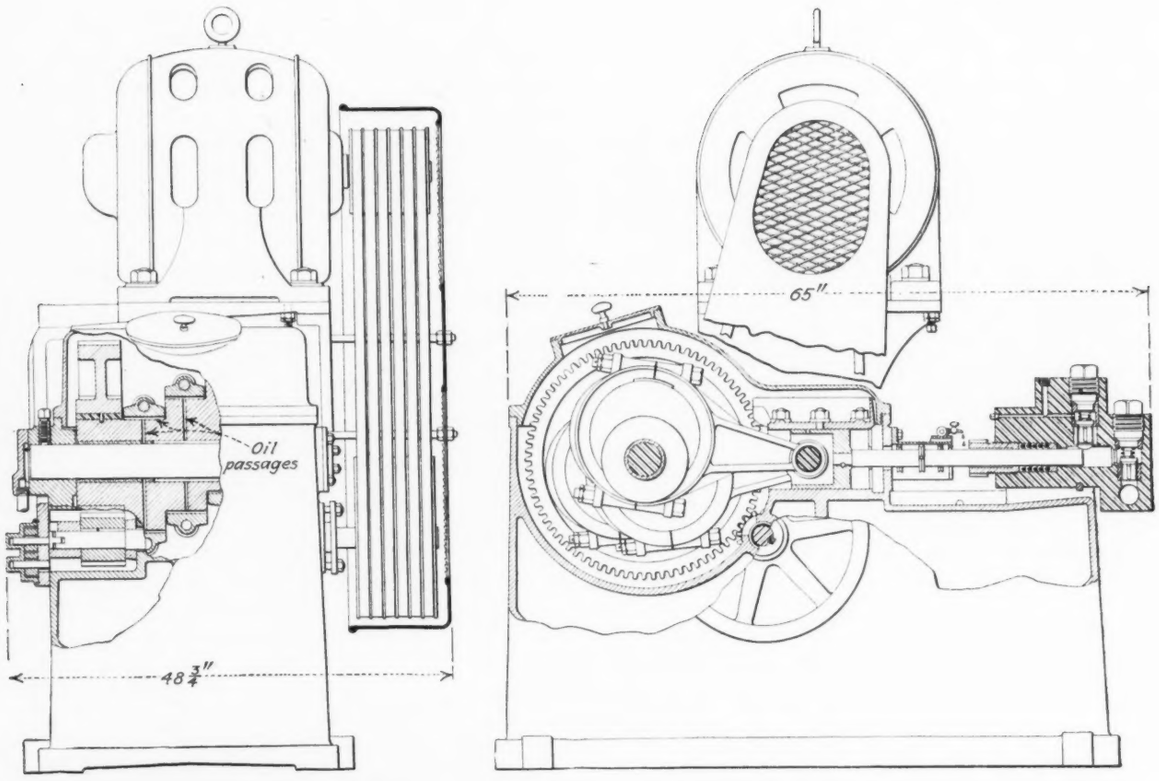
J. H. Ladds
Vice-president in Charge of Sales

In an accompanying illustration is shown a cross-section of the viscolizer unit, which is screwed on the top of the cylinder block. It is in this unit that the maximum effect of high pressure and liquid erosion must be resisted. The flat, thin spray of liquid passing between the valve seat and valve impinges at high velocity against the beveled edge of the spacer and is deflected through slots in this spacer. The height of opening between the seat and the valve controls the velocity of the liquid, and the opening to the level at the end of the spacer and the size of the slots in the spacer control the mixing or "viscolizing" of the product. The valve, seat, and spacer are of cast Stellite ground to shape. It will be noted in the cross-sectional view that both the valve seat and the valve plunger are ground alike on both ends, which makes them reversible, thus doubling their life in service. The viscolizer valve body and inlet plug are of cast hydraulic bronze, and the spring case is a bronze casting. The coil spring is of special heavy square wire, purchased from spring specialists, and is so designed that the opening of the valve can be adjusted to the desired pressure by means of the hand screw. The packing around the stem that holds down the viscolizer valve is cup leather with bronze spacers, or it may be commercial packing of the seal ring type.

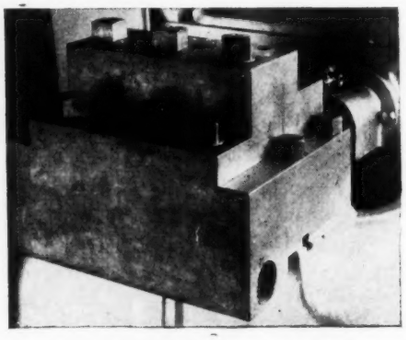
An important accessory of the machine is the gage for regulating the



VALVE ASSEMBLY, where the liquids pass at high pressure. The valve and seat are of cast Stellite. Finger adjustment is possible up to 5,000-lb.-per-sq.-in. pressure



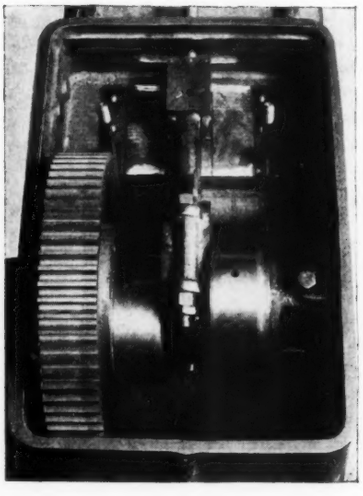
THE DRIVE and the cylinder valves are clearly shown in the view at the right above. The top cover of the machine has no bolts and can be lifted for inspection. At the left, the oil pump connection to the intermediate shaft, the cam block, gear, and eccentrics are shown. Oil from the pump is forced through the fixed main shaft to the cam blocks and insures lubrication should the oil in the crank case be allowed to run low



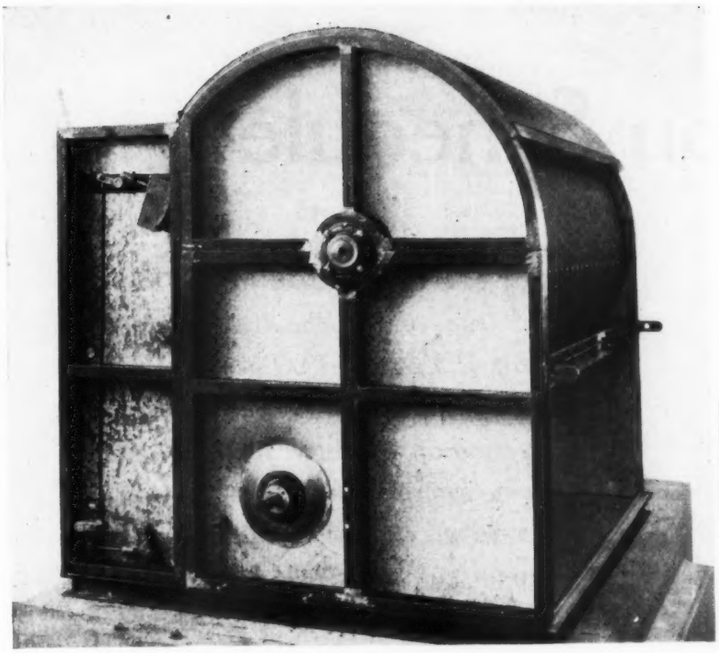
THE CYLINDER is machined from a slab of high-chromium stainless steel and is keyed and bolted to the cast-iron frame

pressure. The gage used, shown in cross-section, is a Manning high-pressure type with needle valves to control the passage of the liquid and measure by direct contact of the liquid being viscolized.

Viscolizers are installed largely in food-products plants where neatness and cleanliness are considered of outstanding importance. This factor was given attention, therefore, in designing the straight, trim lines of the present machine. All working parts that are lubricated are totally inclosed, running in oil, so that there is no opportunity for oil splashing out or for the collection of dust and dirt. Aluminum paint, over a primer and filler, is used on the cast-iron frame, covers, and guards. The aluminum color fits in well with the color schemes of food manufacturing plants, and is likely to appear cleaner for a longer period than white paint. The steel cylinder block is finished by dipping in molten tin. In addition to the fact that tin has a desirable color for this purpose, it is conceded to be the most sanitary metal for machines of this type.



CAM and gear block in position with two of the eccentrics removed. The crossheads operate close together and take the thrust on the bottom



Drying tumbler frame fabricated of welded steel

Extractor pedestals of welded steel, as shown on the right, cost less and weigh less than the older type of cast iron, shown on the left

Laundry Machinery Fabricated by ARC WELDING

By MAURICE TAYLOR
The Lincoln Electric Company

THE scope of products being fabricated by welding continues to widen in ever-increasing circles. The advantages of this process are so many and so varied that engineers in practically every industry have adopted it in an attempt to improve their product.

The entire frame of the "American" drying tumbler shown is fabricated of arc-welded steel. This frame is made up from pieces of steel channel cut to size and fused together by welding. The cast-iron frame weighed 635 lb. and cost approximately $58 in ordinary production. The new frame is practically the same in appearance and is constructed of rolled steel shape. The joints are made by fusing the members together at their edges, making the entire frame one homogeneous unit of steel. This arc-welded steel frame weighs only 370 lb. and cost approximately $18.75 to produce. It took 16 hours to produce a frame of cast iron and prepare it for assembly. The welded frame took only 7.6 hours.

A cast-iron and welded steel ironing stand leg is illustrated. Here again costs are greatly reduced, and beauty and symmetry are preserved in the welded leg. The cast-iron pedestal for a laundry extractor weighs 91 lb. and cost $6.33 to make. Its welded successor, also shown, weighs 52 lb. and was manufactured on a production basis for $3.17. The weight saving (for three legs) is 117 lb. and the cost reduction is $9.48.

Cast-iron and welded-steel ironing stand leg

Designing on Schedule

A SIMPLE system for scheduling the work of the drafting department is described. The system has been in satisfactory operation over a period of several years, in a department wherein the types of designs developed change constantly and the amount of work to be scheduled is also a variable quantity

THE WORK of the drafting department is primarily to depict the engineering design, so that those who are to materialize the design will know exactly what is desired. In earlier days the chief draftsman usually played the role of assistant chief engineer, as well as the managing head of the drafting department. More or less of the details of design were left for him to solve. This is still the situation in most drafting rooms, and where only a relatively small amount of drafting work is done, it is probably the most economical arrangement. However, as the number of draftsmen increases, the managerial duties of the chief draftsman become greater and more important. In the case of the engineering department referred to in this article, all of the designing is done by engineers, and the chief draftsman devotes all of his attention to the operation of his department as a production unit of the engineering division. The chief draftsman then functions primarily as a production manager. As is true for all production departments, in order to operate efficiently, the work to be done must be planned and routed.

DRAWING RECORD.

TO THE CHIEF ENGINEER:
PLEASE AUTHORIZE THE FOLLOWING DRAWING

DRAWING No. 12101
DESCRIPTION: 20" Diam. Shell - Assembly
W. R. No.
E. O. TITLE 20" Diam. Converter
E. O. No. 1206
WHY REQUIRED Schedule of Drawings
DATE REQUIRED March 2,1929
Chief Draftsman
Initials C.H.T. E.C. W.H.R.
AUTHORIZED BY T.C.Morma. DATE Feb. 2 1929 DATE CLOSED Feb. 24 BY L.J.S.

	Estimated Time	Actual Time	REMARKS
DESIGN	5	10	
DRAFTING	45	42	
TRACING	20	20	
B. M.'s	4	4	
SPECIFICATIONS	6	6	
CHECKING	15	14	
COMPUTATIONS	10	14	
ESTIMATES			
INSPECTION			
TOTAL	105	110	

TIME TAKEN ON REVISIONS

Issue No.	Remarks
2	
3	
4	
5	
6	
7	
8	

ESTIMATED TIME for each operation is entered on the original of the quadruplicate drawing record card. Actual time is entered after completion of the job

There is a prevalent opinion that engineering and design work cannot be scheduled. If one suggests such a procedure the reply will usually be something like this: "Most drafting details and tracing may be scheduled; engineering and design, never, at least not the complicated work in our engineering department. Why, we frequently draw up five or six designs before we get what we want. Other times the first or second design proves to be satisfactory. How could we possibly foresee such conditions?"

Yet every time a chief engineer or chief draftsman demands that a job be finished by a certain time he is unconsciously scheduling that job, even though he follows no system in doing so. And at least one engineering department has successfully operated, over a period of several years, under a system wherein all of its engineering work was scheduled. Nor is its work exceptionally simple; most of it is special. Scarcely ever are there more than two or three variations of a given design made.

Schedules in this engineering department are not maintained by throwing in extra men as needed in order to speed up designs that are falling behind. Nor is the volume of the work very steady. Over a period of two years the number of men employed in the drafting department has varied by as much as a ratio of 10 to 1. The system this company uses in scheduling its work has operated satisfactorily when the department was small as well as when it was large, and it operated when the size of the department and the volume of work going through was rapidly changing.

The system used for maintaining the schedules is really very simple. When the engineering department undertakes the design of a machine or piece of equipment, the chief engineer initiates the work by issuing an

SCA-35ab 5m 1107-7-28

CARD NO. 1 OF 1

DRAWING RECORD

E. O. No. 1206 C. O. No. WORK REQUEST No. DRAWING NO 12101

Name	W. W. Luck						H. E. Horner						H. E. Horner						S. Crawford					
DATE	3/4	3/6					3/6	3/7	3/8	3/9	3/11	3/12	3/13	3/14	3/15				3/18	3/19	3/20			
DESIGN	5	5				10																		
DRAFTING							8	8	8	8	8	2	42											
TRACING																								
B. M's												4	4											
SPECIFICATIONS												2	2	2	2			4						
CHECKING																			6	7	1			14
COMPUTATIONS																								
ESTIMATES																								
INVESTIGATION																								
TOTAL	5	5				10	8																	
Name	I. C. Smith																							
DATE	3/21	3/22	3/23																					
DESIGN																								
DRAFTING																								
TRACING	8	8	4			20																		
B. M's																								
SPECIFICATIONS																								
CHECKING																								
COMPUTATIONS																								
ESTIMATES																								
INVESTIGATION																								
TOTAL	8	8	4			20																		

A DRAWING RECORD card issued to the squad leader for his men to report the time spent on the drawing

E. O. No. 1206 **RECORD OF ACTUAL TIME SPENT ON - DRAWING NUMBER** 12101

TIME CARD NUMBERS	DESIGN	DRAFT'G	TRAC'G	B.M's	SPEC'S.	CHECK	COMP.	EST.	INVEST.	INSP.	FIELD		RUNNING TOTAL
14636	10												10
14640		10											20
14659		32											52
14662				4	6								62
14666							14						76
15001						14							90
15003			15										105
15119			5										110
TOTAL	10	42	20	4	6	14	14						110

THE TIME CLERK enters on this card the total time spent on the drawing operations

ALL DRAFTSMEN daily enter on the weekly time card their time spent on each Job

TECHNICAL DEPARTMENT ENGINEERING DIVISION

WEEKLY TIME REPORT #14659

Name A.E.Horner Week Ending Feb. 9,1929

	DATE	Mon. 2/4		Tues. 2/5		Wed. 2/6		Thurs. 2/7		Fri. 2/8		Sat. 2/9		Total Hours
	DESCRIPTION OF WORK	DWG. NO. OR JOB	Hours	DWG. NO. OR JOB	Hours	DWG. NO. OR JOB	Hours	DWG. NO. OR JOB	Hours	DWG. NO. OR JOB	Hours	DWG. NO. OR JOB	Hours	
E. O. No. or W. R. No. 1200	Design and Invest'gn													
	Drafting	11988	2	11988	6									
	Tracing													
	B. M.'s	"	2											
	Specifications													
	Checking													
	Computations	"	4	"	2									
	Estimates													
	Inspection													
	Daily E. O. Total		8		8									16
E. O. No. or W. R. No. 1206	Design and Invest'gn													
	Drafting					12101	8	12101	8	12101	8	12101	8	
	Tracing													
	B. M.'s													
	Specifications													
	Checking													
	Computations													
	Estimates													
	Inspection													
	Daily E. O. Total						8		8		8		8	32
E. O. No. or W. R. No.	Design and Invest'gn													
	Drafting													
	Estimates													
	Inspection													
	Daily E. O. Total													
	Daily totals		8		8		8		8		8		8	48

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engineering order, called an E.O. This order specifies in a general way the work to be done and assigns the job to the engineer or engineers who are to be responsible for its execution. In issuing this order the chief engineer also specifies the approximate date when the design must be completed. This is done in order to give the men who later schedule the drawings a basis upon which to operate.

Each engineer is assigned to that phase of the work to which he is best suited by training and experience. For example, there are mechanical engineers, civil engineers, steam engineers, electrical engineers, field engineers, and such other types of engineers as may be necessary to round out the organization. Where the amount of work falling in any one classification is relatively small the duties falling in two or more classifications may be assigned to one of these engineers.

Should the engineering design ordered by the chief engineer involve thermodynamic or process calculations, this phase of the work is assigned to a development (or project) engineer, who then sets up the required features of the design with such notes, typewritten or otherwise, as may be necessary. His drawings are generally freehand sketches giving such of the important governing dimensions and requirements as may be involved. Upon completing his work the development (or project) engineer supplements it to the engineering order which he has received and sends all of the matter to each of the engineers concerned with that particular job, forwarding a copy to the chief engineer.

When an engineer receives the engineering order, (E.O.), from the chief engineer or, if development work was required, the necessary material from the development engineer, he schedules the job or that portion of the job assigned to him. To do this he lists the drawings which will be required, giving each drawing a tentative title. Then he or his assistant estimates in detail the time required to do the necessary detailed design and drafting work. These estimates are based upon information contained in records which will be described later. The dates which the engineer sets are considered as his promise to the chief engineer that he will execute, as per schedule, the work that he has laid out for himself. The experience of this particular engineering department has been that in most cases the engineer lives up to his promise.

In the drafting department, the men are split into squads, each squad having its leader. A squad leader is assigned to each of the assistant engineers. The actual work of scheduling the drawings is done by the squad leaders under the close supervision of the engineer in charge of the work.

The drawing schedule, upon completion, is scrutinized

by the engineer and the chief draftsman, who revise the list where necessary or advisable. The schedule is then sent to the chief engineer for final approval. Upon authorization by the chief engineer, copies or blue prints of the schedule are issued to each engineer concerned, the drafting squad leader, and the chief draftsman.

Drawing-record cards such as shown in the accompanying figure are made out for each drawing listed on the schedules. This work is done by the squad leader under the supervision of the engineer; the typing of the cards in quadruplicate is of course done by a typist. This card is initiated by the squad leader, signed by the chief draftsman, and is then submitted to the engineer in charge of the squad for authority to proceed with the work. No drawing may be worked upon unless authorized in this manner.

ALL the cards are ruled the same and bear the same information on the front faces. The first and second of these cards are white in color and bear the same information. One is filed in numerical order in the office of the chief draftsman and the other is filed according to the engineering order number in the office of the production clerk. The third card is yellow and is issued to the squad leader; the reverse side of this card being ruled for recording the time spent on the drawing. This card is usually attached to the drafting board where its respective drawing is being worked upon, and accompanies the drawing throughout the checking and tracing stages.

The fourth card is red and is sent to the time clerk. The reverse side of this card is ruled for recording the total time spent for each operation on the drawing. This information is obtained from the weekly time cards which are issued to all draftsmen, who daily enter on them the time spent on each job, indicating the engineering order number, drawing number, hours spent, and type of work done (drafting, checking, tracing). These time cards are collected daily, their entries posted on the drawing record cards and re-issued the next morning.

The drawing record cards enable the time clerk to determine the actual time spent on each drawing. When the drawing is completed the actual time for each operation is posted in the column provided on the two white cards, thus giving a comparison against the estimated time. One white card is circulated to the squad leaders and engineers concerned so that they may use this information in estimating future jobs of a similar nature. Explanations of overrun or underrun of estimated time are noted by the squad leader on the card circulated.

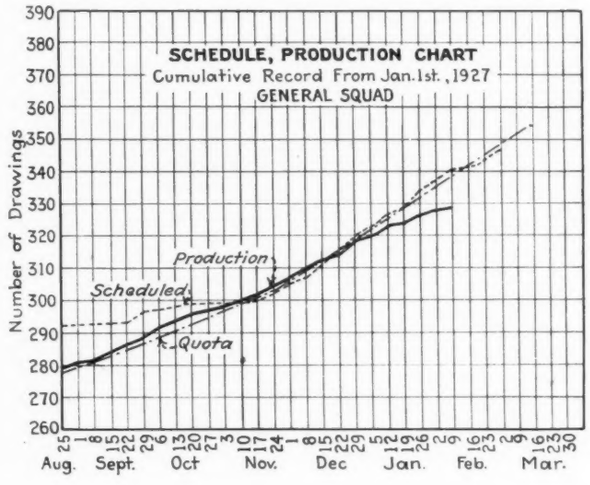
The average time required to finish a drawing is also used in determining the expected weekly production of drawings or quota per squad. Other factors in making up the quota are the number of hours worked per week, the number of men, and the absence factor. The absence factor is to account for sickness and vacation. The hours of work per week per man, times the number of men, times the quota factor, that is, 100 per cent minus the absence factor, divided by the average time required to complete a drawing, will be the number of drawings which should be completed in one week by a given squad. In this manner, the quota assigned to each squad is determined.

When the drawings are finally approved and ready for issue, they are routed to the production clerk who will make the necessary entry on the E.O. schedule and also on the drawing card, noting particularly the date of issue of the drawing. Each completed drawing is awarded one point and is credited to the squad which produced the drawing as part of its quota.

If drawings vary in size, some other basis for award and quota may be used. This may be arrived at by studying the average time spent on groups of drawings made on various sizes of sheets, and assuming that the size of drawings most generally used is standard.

An effective curve, here illustrated, may be used to show the past performance and future work scheduled as compared to estimated quota figures. This curve will show whether a squad is meeting its quota and will assist greatly in scheduling future work, quickly indicating capacity for work at a future period. Care should be exercised that squads do not become over-scheduled unless additional man-power is assured. Similarly when underscheduling is shown, it indicates that the squad is running out of work and that the leader should release some of his men unless additional work to be done is forthcoming. These curves should be made for each squad, and a composite curve plotted for the entire drafting section. By plotting these curves on vellum or tracing cloth, using blue-print copies for distribution, the chart readily can be kept up to date and revised as necessary.

To assist in the preparation of these curves, it will be found necessary to tabulate the data as illustrated.



This chart provides space for each drawing scheduled by each squad for all E.O.'s or jobs and is divided into weekly sections for several months ahead. This chart alone will show at a glance the amount of drafting work to be done, and on this basis the number of men employed in the drafting department may be regulated so as to eliminate unnecessary layoffs caused by hiring too many men for the amount of work to be done.

Economies to be derived from the systematically scheduled operation of an engineering department are many, in addition to the very apparent ones. Such operation, particularly when speeded up by the use of modern methods and equipment, not only decreases the unit cost of the engineering work, but also effects economies in other departments. Requisitioning of parts and materials is speeded up. The purchasing department is thus given more time to do its work, usually resulting in more satisfactory purchases. In the production department delays and shut-down awaiting engineering designs, are minimized.

Checking Machine Layouts with Charts

D. D. DEMAREST
Consulting Engineer

SOME form of timing chart or diagram is essential in designing automatic production machines. Drawings do not move, yet an engineer must know what will happen at every moment in a cycle of operations. He must be sure that each moving part will go through its cycle without interference and in proper relation to every other part. There are only 360 deg. in a revolution, and it is often a difficult problem to work in all the desired consecutive motions in the time that is available. This is particularly true when maximum speed is required, as high speed limits the time available for each motion. A carefully worked out timing chart is the only feasible means for showing that every portion of the entire cycle is being utilized to its full capacity.

Simple machines may be studied by indicating the motions of the parts on a circle laid off in degrees, as shown in Fig. 1, which is a conventional timing chart of a four-cycle gas engine. This engine is chosen as an illustration because its mechanism is so well understood.

The circle chart tells when the most important things happen, but it gives little information for a careful study of the instantaneous relation of the various moving parts at any given time. It is possible that this diagram can be elaborated, but usually the more that is put on it, the more confusing it becomes. Then too, only three moving parts are involved in the gas engine mechanism, while in an automatic production machine there may be a dozen or more.

To show the varying relations of many moving parts the type of chart shown in Fig. 2 has proved adaptable to a wide variety of machines. In this example, the chart portrays the motions of the same engine as chosen for Fig. 1, but tells much more of the story. The chart shown in Fig. 2 is plotted so that the movement of each element is indicated by the vertical

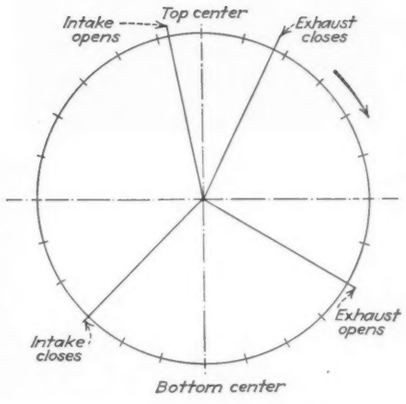


Fig. 1—Circular timing chart for a gas engine

displacement of its individual curve, and all curves are plotted against degrees of movement of the main shaft. A complete cycle of the engine requires two revolutions, a fact which is readily shown on this chart, but which is hard to indicate clearly on the circular timing chart.

The upper curve shows the action of the piston. The distance of any point on this curve from the tangent line gives the location of the piston at that instant. Piston speed at any point is indicated by the slope of the curve.

Intake and exhaust valve actions are shown by the second and third curves respectively. The positions at which these curves depart from and return to their base lines may merely indicate the opening and closing times of the valves, or the curves may be carefully worked out to scale in order to indicate the variations in the size of the valve openings or the amount of rise of the valves above their seats.

The indicator diagram, which is the fourth curve on this chart, gives the cylinder pressures during the entire two revolutions that comprise one cycle. For example, a partial vacuum is produced by the rapid travel of the piston in the middle of the suction stroke. Similarly, there is a slight increase in pressure during the middle of the exhaust stroke. If these curves were plotted carefully to scale, and if the speed, dimensions, and other factors were duly recorded, this chart would tell quite a complete story to an engineer.

Designers of production machines will find this type of chart useful. Every moving element is plotted on a separate section of the chart, hence its curve can readily be altered without interfering with any of the other curves. If the curves are plotted to a liberal scale the probable hard motions will be shown by steep slopes. To iron out these spots it is usually necessary to overlap the motions to some extent. This results in a great economy of time in the operation of the machine when the motions are being uniformly accelerated, three quarters of the movement occurring during the middle half of the period of time. A slow start and stop for each motion makes an easy running machine, but will slow it up considerably if each motion is required to end before the next begins.

A small scale layout of the complete machine, together with a timing chart, may sometimes be put on the same sheet. I find it more useful to put the chart alone on a large size sheet and allow room not only for the curves, but also for all kinds of notations and dimensions.

If there are two or three ways in which the same machine can be adjusted, the engineering department ought to know about it, for it indicates that the entire cycle is not being utilized to the best advantage. Under such conditions, a redesign of the operating mechanism will often result in a smoother running machine.

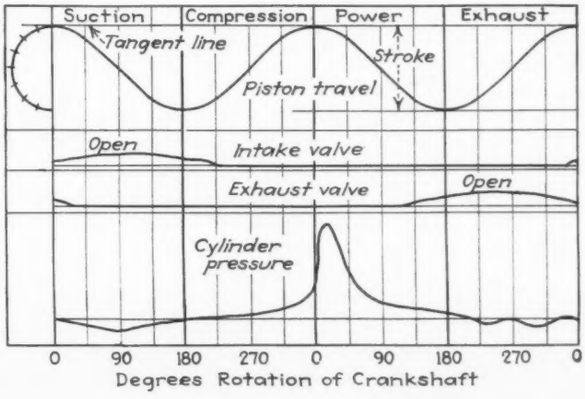
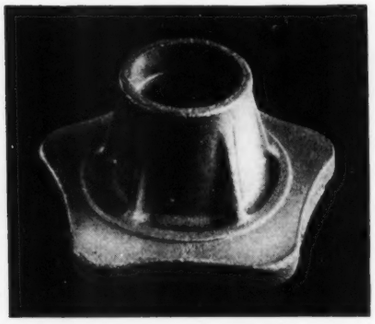


Fig. 2—Projected timing chart for a gas engine



Differential case

Differential carrier

Differential carrier

MALLEABLE IRON

✦ Malleable Iron ✦	
Elastic limit	30,000 lb. per sq. in.
Ultimate strength	50,000 lb. per sq. in.
Elongation in 2 in.	10 per cent
Brinell hardness	110

POSSIBLY few people have considered that the economic production of automobiles is extremely difficult without the use of malleable cast iron. Serious attempts have been made by powerful interests to build cars without the use of this material, and although to do so is an engineering possibility, it has by actual trial proved impossible to do so and sell the resulting car on the open market at a profit in competition with similar jobs not arbitrarily limited as to choice of material.

The close interdependence of the two industries is demonstrated by the fact that business statisticians are able to predict fairly accurately the production rate of cars six weeks in advance by considering the current rate of the production of malleable castings of the country. If the facts be thus, it may be of some interest to examine why a given material is so universally used for certain purposes. The fundamental reason must, of course, be because it makes it possible to buy the requisite properties at the least over-all cost, for this is the reason which always determines finally what material of construction is to be chosen for a given purpose.

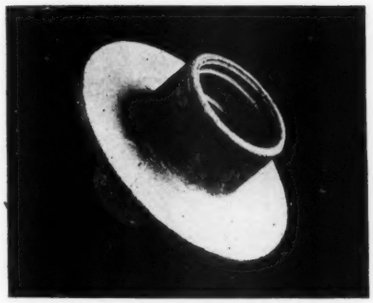
What, then, are the sought for properties? Automotive design involves, universally, certain parts which are, inherently, of somewhat complex form. They must be rigid, must be accurately machined, and in addition to being of sufficient strength to carry the stresses of service and minor accident, must be free from the possibility of failure, due to major accident, of such character as to render that accident more serious than it already is. In addition, the strength desired must be secured within certain limits of weight and obviously, within certain limits of cost.

Complexity of form is usually difficult to attain in forgings or drawn steel parts. When attained in the latter form, cost considerations both with regard to material and labor, set limits on the thickness of stock which is reflected in a limitation on rigidity. The multiplicity of random service stresses finally results in some deformation affecting the alignment of parts. The squealing brake drum, which has ceased to be truly circular due to some unexpected minor stress, is a case in point.

For certain purposes, especially where very high unit stresses are requisite, the forging is the proper and invariable solution. Within the limits here set, however, it is handicapped by the difficulty of forming complex bodies, especially where they are required to be hollow and where the complexity of form is in the interior of the detail.

The drawn-steel part is rarely machined to any great extent, the forging usually entails rather excessive machining for the removal of surplus material existing because of the difficulty of attaining the desired form at every point within the limits of the operation. The assembly of drawn or forged parts welded together is open to the objections that it involves extra operations and has needless joints that may or may not be perfect, but certainly are not stronger than an integral construction.

Even where the total amount of machine work is identical, the malleable casting far outstrips all competitors in cheapness of machining. This material can be machined more cheaply than any other ferrous material or any other material of equal strength. Since the parts indicated



Wheel hubs

Wheel hubs

Differential case

CASTINGS in Automotive Design

By H. A. SCHWARTZ

Manager of Research,
National Malleable and Steel Castings Company

invariably require many and precise machining operations, this is a factor of outstanding importance. Indeed, there are many instances where ease of machining alone determines the selection of this material for purposes where form is the only requirement.

It is extremely difficult to compare, on a commercial basis, the machinability of even the most freely cutting steels and malleable iron, for there are substantially no cases where objects that can be made of malleable castings are made in steel. Certainly, the statement that the malleable casting can be machined at cutting speeds several times faster than rolled product, is reasonable. Nor is the difference decreased by the use of the newer alloy and tungsten carbide tools.

In ultimate strength per unit area the casting is somewhat weaker than low carbon steels. However, as measured by the stress to cause visible deformation, a far more important criterion, it is equal or superior to the carbon steels with which it might be supplanted. Before rupture it will deform far beyond the point where a mechanical detail can still function, so that, unlike gray cast iron, there is no possibility of failure from chance blows or loads or owing to strains set up by the attempts of the chassis to adapt its form to the peculiar positions occasioned by moving over irregular surfaces. It would, of course, be tragic if a steering gear were put out of action because of breaking from its attachment to the frame owing to changes of alignment when traveling a rutty road or rolling over a curb.

Silence in operation of cars is also highly to be desired, and parts which by resonance intensify gear and similar noises are therefore objectionable. It has been found that malleable castings used for rear axle and transmission housings, for instance, greatly minimize difficulties from this cause.

Economic competition within the automotive industry has caused automotive manufacturers to exert great efforts to pass on the desired reduction in car costs to those furnishing them raw material. This pressure is in the direction of both lower prices and narrower tolerances to eliminate as much machining as possible. "Coin pressing" for example, has come into use for the sizing of certain parts.

In spite of the increased difficulties entailed by the demand for more nearly perfect castings, the malleable industry has been able to reduce its prices to a remarkable degree by the introduction into some of the larger plants of some of the most modern and efficient mechanical equipment. All this to the end that needless labor consuming steps in the long annealing and cooling process be eliminated and those remaining be performed in the most effective possible manner.

The repetitive character of automotive work, of course, makes malleable iron particularly suitable to such production methods, for only a large volume of business of a given kind will carry the financial burden of elaborate equipment and administrative study necessary to produce the economies enumerated. There are, of course, other industries in which a similar multiplicity of industrial parts are required and where the malleable casting can and does produce similar economies.

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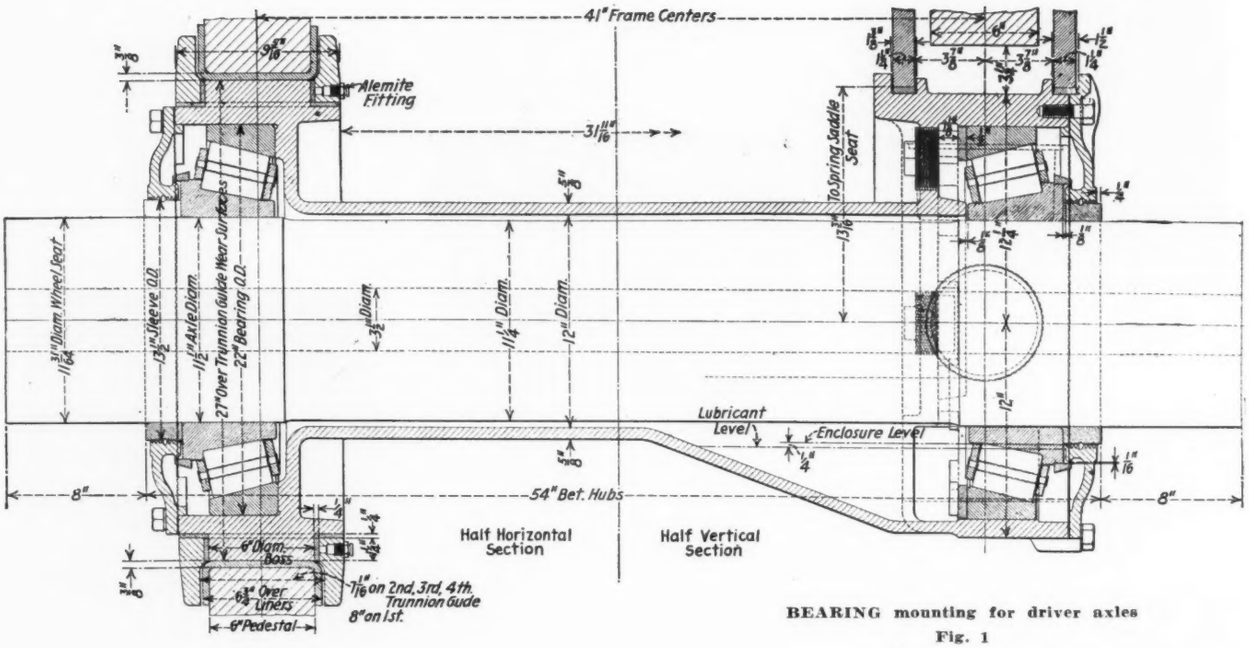

BEARING mounting for driver axles
Fig. 1

BEARING MOUNTINGS in the Timken Locomotive

AMONG the various problems connected with the design and construction of the Timken locomotive, those involved in the application of the bearings to the various axles and shafts are of unusual interest to designing engineers in general. Concerning the running gear, the situation may be summarized in the statement that there were four distinct roller bearing applications, each with its own individual characteristics and requirements to be met. As a result there are four types of mounting represented, each of which has been designed according to the demands of its particular case. In some of them, such as the engine trucks, for instance, there was previous experience to serve as a guide, but others, particularly the driver mountings, had to be designed on a purely theoretical basis. At least there were no existing data to serve as a check on calculations or mounting practices. Furthermore, the application of roller bearings, in at least two instances, involved a redesign of the surrounding parts in order to accommodate the larger bearing boxes necessary, and to meet certain other requirements.

In addition to bearing considerations connected with the running gear, there were two mountings in the booster, namely, the idler gear and the crankshaft, that called for new designs. Since the requirements in these two cases were quite different from any of those encountered in the running gear, these mountings have very little in common with each other. The remainder of the bearing mountings, located in the headlight turbine, train control systems, and valve mechanism, are practically standard, and therefore hardly come within the scope of this discussion. As for the others, however, the mounting designs used are sufficiently interesting to merit detailed description, if for no other reason than their novelty.

In the driver axle mountings, the principal requirements can be outlined briefly as follows: The speed is comparatively high, and the radial loads are heavy, calling for a capacity of

T. V. BUCKWALTER
Vice-President
Timken Roller Bearing Company

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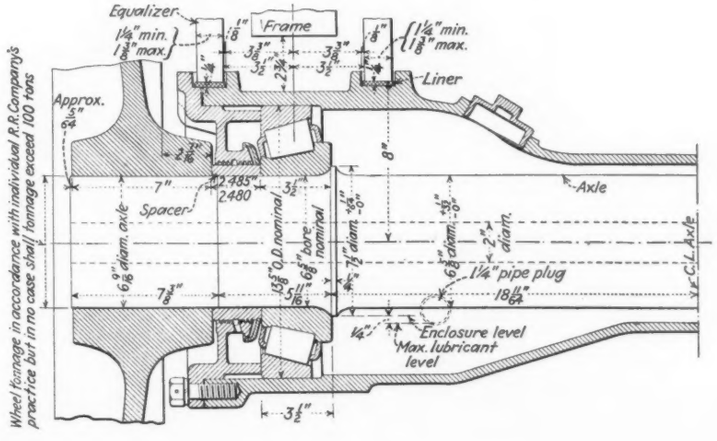
about 31,000 lb. per bearing. There is also a considerable thrust component which fluctuates in magnitude according to the speed and the nature of the road bed, with regard to curves, track levels and other factors. In addition there is a piston reaction load to be considered, which, as far as the bearings are concerned, results in a series of shock loads of varying frequency and intensity. And finally, railroad service requirements necessitate some provision for comparatively easy assembly and disassembly of the mountings. The design had to be such that these processes could be carried out with the standard equipment found in most railroad locomotive shops. The mounting that was developed to meet these requirements is shown in Fig. 1. It might be explained that this drawing shows two sections in two different planes, that to the right being in the vertical and that to the left in the horizontal plane.

The bearings are mounted in a housing that extends the entire distance across the frame of the locomotive, one bearing being mounted at each end. Bearings of 22 inches o.d. are used, the capacity being such as to provide a high factor of safety under any conditions of speed, radial load, and thrust load that may be encountered. In assembly, the cones, or inner races, are given a tight press fit on the axle, a spacer between the wheel and the cone serving to locate the cone and to form part of the outer closure. The cup arrangement is somewhat more complicated. It will be noted that the right hand end of the housing is equipped with three pipe plugs having bosses that project through holes in the housing. The inside of the housing is provided with lands, or bosses, that correspond to lands on a ring that is placed between the bearing cup and the housing. In assembly the ring is adjusted so that its lands come against the lands on the housing. The three pipe plugs are then screwed in, engaging slots in the ring and preventing its rotation. The bearing cups are then pressed against the ring. The cone and spacer are mounted almost in position and the axle is pushed through the housing, after which the other cone and spacer are mounted, the cup having been previously placed in the housing. The wheels are pressed on, and the whole assembly finally adjusted from the right hand side by means of shims between the end of the axle and an adapter plate.

In disassembly, the pipe plugs are removed and the ring tapped with a brass or bronze rod to relieve any pressure that may have been set up. Then it is a simple matter to turn the ring until its lands drop into the grooves in the housing, which drops the ring back about $\frac{1}{2}$ in. This allows relief for the cup, and prevents any possibility of its "brinelling" when the clearance between the cone and the housing is taken up in the press. The housing is then mounted in a wheel press, and pressure is exerted until the cone and spacer are pushed clear of the axle. It is then easy to pull the axle clear of the housing and press the other wheels and bearings off in the usual way.

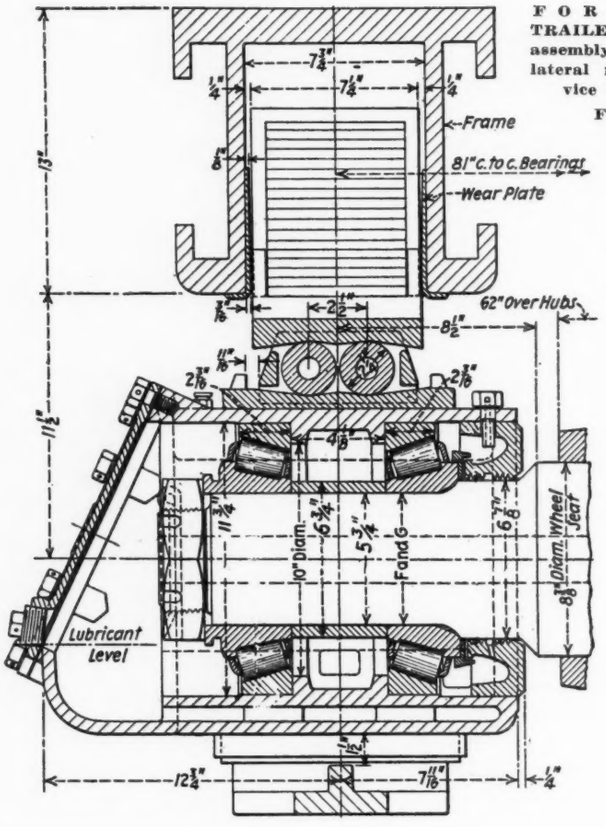
THE use of roller bearings has resulted in several other departures from conventional design which are of interest. In the first place, the main frame had to be provided with pedestal openings considerably wider than is usually the case, 27 in. to be exact. The structure of the frame itself was altered accordingly. The widening of the pedestal openings meant that longer springs and shorter equalizers would be necessary. As a result, 50-in. reverse camber springs with short equalizers were provided, with the net result that the riding qualities of the locomotive were noticeably improved. It was also advisable to dispense with the usual adjustable wedge construction of mounting and to adopt a much simpler arrangement. The bearing boxes are provided with trunnions, over which are fitted guides of hardened Timken steel. The pedestal openings are equipped with liners of hardened and ground nickel-molybdenum steel that are bolted to the pedestal and lap welded to it at the bottom. As a result, not only is the assembly simpler, but much more durable, since all surfaces in contact are made of material that is practically proof against wear. Even the portion of the housings under the spring saddles is protected by hardened steel wear plates. And, since these surfaces are thoroughly lubricated, wear is reduced to a negligible amount. The necessary lateral motion is provided for on the first driver by an Alco lateral motion device which allows 1 in. lateral play, and on the other drivers by clearances that allow $\frac{5}{16}$ in. lateral motion.

The mounting developed for the engine trucks resembles that just described in several respects. Of course, smaller bearings are used, because the loads are much lighter and the general requirements are not so severe.



ENGINE TRUCK MOUNTING. The type of shoulder adopted adds considerably to the strength of the axle

Fig. 2



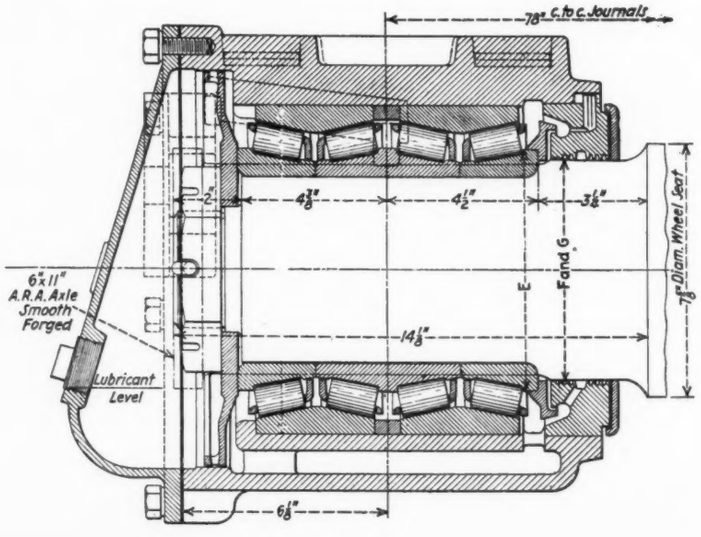
FORWARD TRAILER TRUCK assembly, showing lateral motion device adopted

Fig. 3

In this case also, the bearings are mounted in a housing extending entirely across the frame, but the details of the actual mounting arrangement, as shown in Fig. 2, are much simpler. The bearing cones are pressed on the axle against a shoulder that serves to locate them. The shoulder is different from the usual axle shoulder, being at a 45-deg. angle at the top and sloped off into a long radius at the root so as to give the effect of a long radius shoulder. This construction not only increases the strength of the axle by eliminating the weak spot at the base, namely, stress concentration at the root of the shoulder, but also provides a stronger backing for the bearing cone. A series of thorough tests has proved conclusively that there is no tendency for the cone to ride up the shoulder when it is being pressed into place. After the cone at one end is in place the spacer ring is pressed on and the axle slipped through the housing, the next step being to mount the other cone and ring. The cup at each end, which fits lightly in the housings, is then put in position, and the closures bolted on. The mounting is cup adjusted by means of a shoulder on the closure and shims between the closure and the housing. After the bearings have been properly adjusted the wheels are put in place, being pressed on until the inner surface of the hub bears against the spacer ring and pushes it against the cone. This serves to lock the whole assembly firmly in place.

Dismantling of these engine truck axle mountings is quite easily and simply accomplished in a wheel press. The construction is such that a similar arrangement of steel casting trunnion guides and pedestal liners has been adopted, as has already been described in the case of the driver mountings. Also hardened wear plates are used between the housing and the spring saddles. With the exception that the pedestal openings are wider, the frame construction is the same as that of the conventional plain bearing engine truck.

THE mounting used in the trailer trucks has almost nothing in common with the driver and engine truck mounting. In the first place, the bearings are mounted in outboard journal boxes, and the whole design is calculated to make the axles interchangeable with plain bearing axles without any alteration in the frame construction. As can be seen from Fig. 3, which is a section of one of the journals, two bearings per box are used at each end of the axle. Two reasons may be assigned for this arrangement. First, in order to cut down the overall cross section to a point equal to that of a plain bearing box, smaller bearings must be used. Thus two are necessary to provide the requisite load carrying capacity. Second, the mounting tends to equalize the load and distribute it evenly on the axle. In this mounting the cups are pressed into the housing and the cones are given a tight fit on the axle, being located longitudinally by means of a proper spacer ring. The box is bench assembled and is slipped



JOURNAL-BOX and bearing for tender trucks, showing method of mounting and provisions for lubricating the Quad type bearing

Fig. 4

on the axle as a unit, after which the bearings are adjusted by means of a castellated nut on the end of the axle. One of the interesting features of the mounting is the provision that has been made for lateral motion on the front trailer assembly. This consists of two rollers that work between wear plates on top of the journal box and underneath the spring band, respectively. These permit the whole axle assembly to move the required distance laterally with perfect freedom, and with minimum wear on the box and spring band. It will also be noted that the frame is equipped with hardened steel liners at the point where the spring clip makes contact with it.

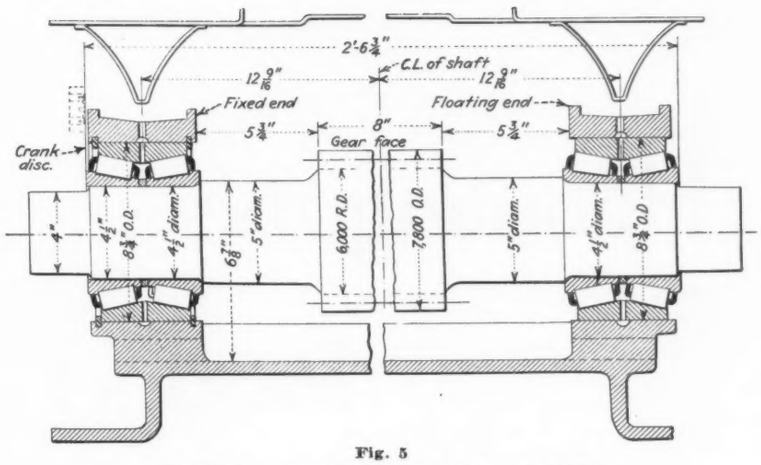


Fig. 5

BEARING mounting for the booster crankshaft

THE tender truck mounting is also an outboard journal box type, intended to replace plain bearing journals without necessitating any changes in the frame construction. It is also bench assembled, and slipped on the axles as a unit. In fact the principal difference between this mounting and that used on the trailer axles is, as can be seen from Fig. 4, the use of a Quad-type bearing instead of two separate bearings. This bearing, which was specially developed for railway use, consists of four sets of rollers with three cones and two cups. In assembly the latter are separated by a spacing ring that is accurately ground to size. The general method of adjustment after the box is on the axle is by means of a nut on the end of the axle. There is one feature of this mounting that is of interest, namely, the means taken to insure uniform distribution of lubricant. It can be seen from the illustration that a large flanged plate having a number of holes drilled through the rim is placed between the adjusting nut and the outer bearing cone. As the plate revolves, lubricant is picked up in the holes and carried to the top of the box. Here it drains into a duct that carries it to the center of the bearing. This arrangement compensates for any tendency of the middle rollers to pump themselves dry. The system has been found to work out very well in practice. As for the rest of the construction, it is more or less standard, the usual hardened steel liners being inserted between the pedestal and the box to limit wear.

Two mountings with interesting characteristics have been made in the booster, one on the crankshaft, and the other on the idler gear. It might be explained that the latter meshes, during the starting period of the locomotive, with the crankshaft gear and a gear on the roller trailer axle.

The booster or auxiliary locomotive contributes to the locomotive tractive effort at starting. When the engine speed has reached a predetermined figure the idler gear is dropped out of mesh. As a result, the bearing service is characterized by heavy loads, suddenly applied, but not sustained, since they fall off quite rapidly as the engine gains speed. The mountings have therefore been designed with these requirements in view. Fig. 5 illustrates a mounting for the crankshaft. The bearing cones are given a tight fit on the shaft, and the cups a light fit in the housings. It will be noted that one end of the shaft is fixed while the other is permitted to float in the housing. This arrangement takes care of any shaft expansion that may occur, and also permits the pinion and gear to align themselves properly under the stress of heavy peak loads.

THE lubrication system developed for this mounting has its interesting points. Two V-shaped baffles have been located above the bearing housings, with their apexes directly over the opening of a duct in the housing. As lubricant is thrown against the baffles by the rotation of the cranks, it drips off the apexes and directly into the duct opening, whence it is carried to the bearing.

In the mounting used in the idler gear, a Quad bearing is pressed directly into the gear hub, the cones being pressed on the shaft and located by spacer rings at each end and in the middle. The cups are given a light fit in the hub, and they bear against a shoulder which definitely locates them. The lubrication system is rather novel in this case also. An oil trough in the top of the housing collects oil and delivers it to a series of openings in the outer closures. These openings connect with a common duct in the shaft and the lubricant is delivered to the bearings through a series of ducts at right angles to it. It can be seen that the spacer between the cones is drilled at frequent intervals to permit the passage of the lubricant.

In addition to the design aspects of the various mountings, the results, both actual and prospective, are of considerable interest from several standpoints, but especially from that of economy. It has already been explained how the construction has been simplified at several points, which in itself represents greater economy. Not only is building and assembly expense less, but operating costs as well, for the obvious reason that, other things being equal, more simple assemblies last longer than more complicated ones. And, in this particular case, advantage has been taken of the opportunity to use materials that are particularly resistant to wear, an opportunity that does not exist to anything like a comparable extent under ordinary circumstances. The bearings themselves contribute to the situation, of course, since their resistance to wear preserves the original setting of the surrounding parts and thereby staves off all sorts of maintenance expense. Then too, their effect on the starting torque and general effectiveness of the locomotive must be taken into consideration in any summary of their influence on operating or maintenance economy.

Handling the Product Research

By B. H. WITHERSPOON
President, Pittsburgh Testing Laboratory

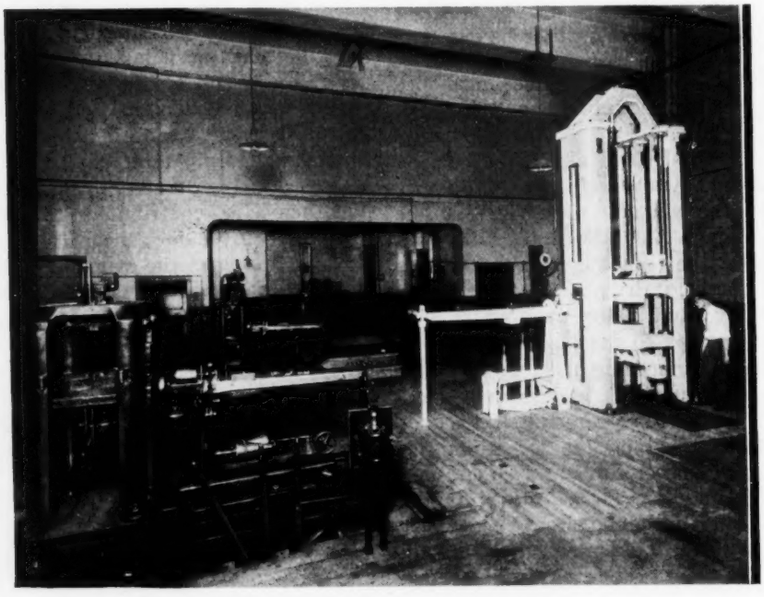
IN ORDER to keep abreast of competition, the designing engineer is forced to incorporate in his product the latest improvements in materials and finishes. The sales organization may be demanding the same product to sell at an appreciably reduced price, which goal possibly may be attained by the use of new materials. In some instances improvement in quality requires the use of special alloys. The advent of new materials and finishes may have made available plant facilities that are waiting to be utilized. In addition there is the constant demand for improvement in mechanical design.

It is impossible for any engineer to sit at his desk and visualize all of the effects resulting from the application of a new material, particularly when its properties and behavior are none too well known, yet one defective product put upon the market may do incalculable damage. To illustrate, one manufacturer designed a steam trap, which, when subjected to ordinary shop tests, functioned perfectly, but when given a comprehensive test in a laboratory, gave evidence of shortcomings which necessitated modifications in design. Another manufacturer produced valves which, under ordinary tests, appeared to operate satisfactorily. After hundreds were sold, however, defects developed in service which made the valves unusable, and the maker never fully recuperated from the black mark received. The first company mentioned paid for experimenting before marketing, and succeeded. The second saved this expense, required the customer to do the experimenting, and failed.

Many similar instances could be cited. Careful investigation and tests ought to precede the marketing of every new product. Otherwise serious losses are almost inevitable. Thousands of dollars often can be saved by adequate research and testing in the first place.

Product engineers must have available the services of a testing or research laboratory which will investigate the suitability of materials and finishes, the correctness of the mechanical design, and finally, will test the finished product under conditions simulating service, in order to certify that, when placed upon the market, the article will render satisfaction.

Many forward-looking industrial organizations have made large investments in research laboratories and personnel, but an even greater number, both large and small, have felt



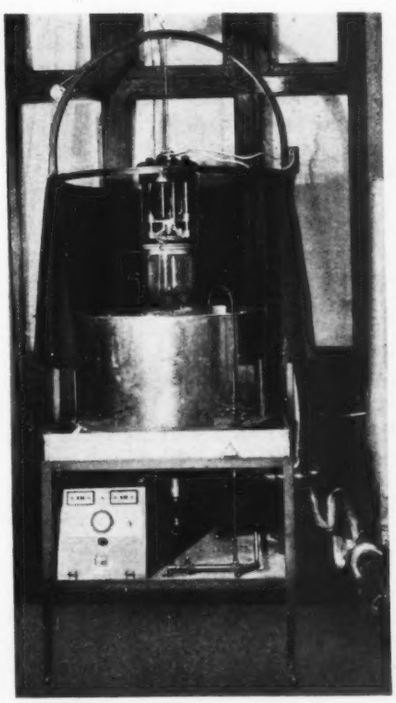
MACHINES for physical tests of materials are important items of equipment in commercial testing laboratories

PITTSBURGH TESTING LABORATORY building, one of many laboratories in which commercial research and development work is done

that a research department would bring about an unwarranted addition to general corporate and overhead expenses. It must be admitted that the expense involved is considerable.

When, for example, a firm decides to install a research laboratory with facilities for studying and developing new processes involved in the manufacture of a metal article, a metallurgist often is placed in charge. He soon may stumble into many intricate chemical problems, and may find that, in addition to a considerable outlay for chemical apparatus, an assistant chemist must be employed. Following this it may develop that certain physical tests of the metal entering into the product are necessary. Consequently, testing equipment must be added, and perhaps a mechanical engineer employed. Before the research yields the desired results several times the original appropriation may have been spent and the original personnel have been multiplied far beyond expectation. Anticipation of such expenses undoubtedly has held back many institutions that recognize an immediate and pressing need for adequate and complete research.

For those manufacturers who are without their own research departments, or who find their present research organization too costly, there are available the services of various semi-commercial and commercial laboratories numbering at least three hundred and located in or near almost all industrial centers. Some are in universities, others are operated under state or federal auspices; and many are privately owned, but open for use by industrial concerns on a reasonable basis. Many such laboratories have upon their staffs competent scientists and engineers, amply qualified to advise, suggest and direct matters falling within their scope, and possess excellent facilities for conducting metallurgical, chemical, physical, and mechanical investigations, under highly trained specialists.

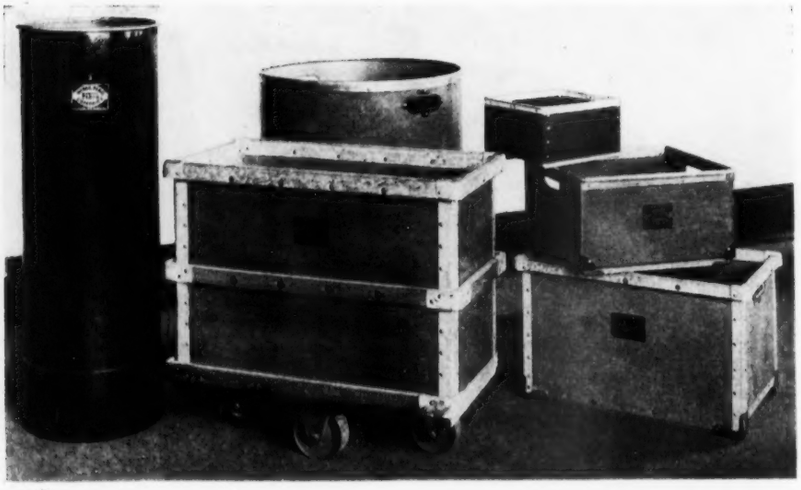


WEATHEROMETER used for testing finishes for resistance to light exposure in the Pittsburgh laboratories

Some of the more progressive laboratories afford facilities whereby the manufacturer may designate one of his own employees as a research associate, and make available to him the equipment of the particular laboratory chosen, as well as the advice, counsel and direction of individual members of the laboratory staff, and also group consideration of the problem to be solved. Such an arrangement has distinct advantages for the manufacturer who lacks or desires to supplement his own research facilities and personnel. It not only enables him to keep in close touch with the work done, but after the completion of the research program, the research associate continuous in the service of the manufacturer. This insures the latter that he will obtain the full and lasting benefits from the research program undertaken.

The use of facilities for scientific research under this plan in strictly commercial laboratories is a recent innovation, yet the plan already has contributed much to industry. Development of new products, and the solution of specific design problems such as are mentioned in the fore part of this article, both are listed among the accomplishments of the leading commercial research laboratories of this country. Undoubtedly these laboratories will go far in making available information not heretofore so accessible to companies lacking research facilities of their own and thus will be of great benefit to the product engineer—the individual around whom the basic program of product development centers.

HARD



CONTAINERS made from hard vulcanized fiber are unusually strong in proportion to their weight

ALTHOUGH hard vulcanized fiber has been manufactured for a great many years, comparatively little is known throughout the industries that use it either of the methods employed in its manufacture, or of its unique characteristics. It can almost be said that there is no large industry today which does not find some use for it.

The name "hard vulcanized fiber" is confusing because of its classification under the term "fiber." This term is so broad that it includes almost everything between paper and metal on the one hand, and between paper and fabrics on the other. Only the words "hard" and "vulcanized" have been learned by the trade to distinguish it from this vast group. Even moisture-proof "fiber" sometimes is asked for when laminated Bakelite is wanted.

Hard vulcanized fiber is essentially different from all other fiber materials in that it is the result of an irreversible chemical reaction. The raw materials are cotton rags and zinc-chloride. The difference between the various grades of hard vulcanized fiber begins with the selection of the grade of rags. Contrary to the general impression, the hardest grades of fiber are produced from the softest most absorbent rags, because of the more thorough reaction of the chemical.

After sorting and removal of foreign materials, rags are shredded and treated in rotary cookers with an alkali to soften the cellulose fibers and to take out any traces of oil or grease. They are then passed through washers, rifflers, and heaters where the color is added; through a Jordan, and onto the screen of a Fourdriner machine. This produces an intermediate rag base sheet of which a special grade must be prepared for each grade and each color of fiber, making it necessary to carry an enormous stock.

Rag base sheet is passed through the zinc-chloride bath, maintained at a concentration of approximately 71 deg. Baumé. There the cellulose is softened and gelatinized so that the several plies adhere to each other. For making very thin fiber, several plies of the rag base sheet are run simultaneously and brought together between heated cylinders, after which the fiber sheet is passed through a series of tanks to wash out the chemical. In making heavier fiber, the sheet is built up on a cylinder to the required thickness, after which it is cut off and placed in a series of purifying tanks. The thin fiber is purified within a few hours, but the heavier fiber takes from a week to several months to remove thoroughly the last traces of the chemical. Zinc-chloride is re-concentrated by evaporation and is utilized over and over again, since none of it is actually used up in the reaction.

Tubing is made in similar fashion by building up the required number of plies on brass mandrels under carefully controlled conditions of temperature and pressure. When placed in water the tubes swell up, after which the mandrels can be removed. The tubes are collected into crates and are passed through a series of purifying tanks the same as fiber sheets. After purifying, the fiber in either sheet or tube form is dried and finally is calendered smooth. Fiber rods are turned from the finished fiber sheets.

IN THE past three years the scientific method of controlling manufacturing conditions has been introduced to such an extent as to be almost revolutionary. Although the process as outlined above appears to be simple, it is really very sensitive. Technical control has reached the stage in which every operation, from the time the rags are received until the fiber is finished, is covered by rigid specifications and schedules. This has made possible consistent production of special grades which are required to meet the specific needs of different industrial applications.

For instance, the trunk industry, which uses hundreds of tons yearly as a trunk-covering material, along with fiber case manufacturers, require a grade of fiber with the utmost strength combined with the flexibility necessary for satisfactory working. It took several years of active research to develop the grade which the industry finally recognized as a distinct forward stride in trunk covering materials. This same grade is admirably suited for the manufacture of hand trucks, boxes, roving cans, and similar items, and for all manner of receptacles needed in modern factories. Textile mills particularly appreciate the fiber receptacles, not only because of their

VULCANIZED FIBER FOR PARTS

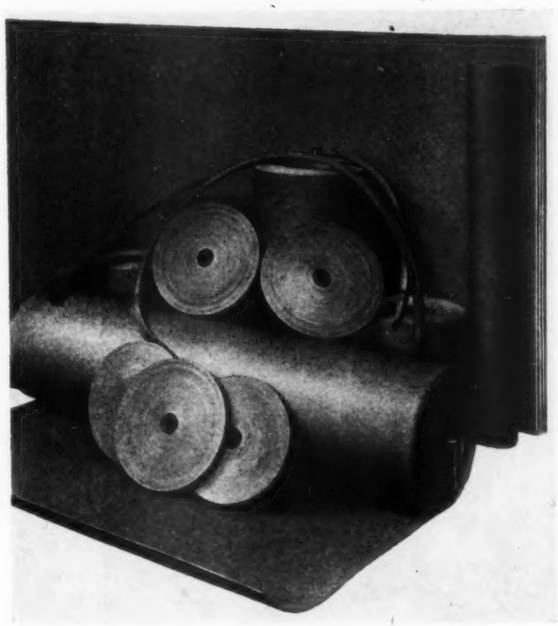
By E. A. RUSSELL

Assistant General Manager, Spaulding Fibre Company, Inc.

light weight and long-wearing qualities, but because they do not splinter or roughen up to catch threads.

For the same reason hard vulcanized fiber is used extensively as spool heads in the textile, rayon, and carpet industries. It is employed by blank-book manufacturers both for covers and backs because, while it is strong enough to lend support, it is light in weight, soft enough so that it will not damage desk tops, and extremely long-wearing because it is solid in color and texture and does not wear shabby like a cloth binding. For fly-leaves and index sheets it is exceptionally tough and durable.

On account of the wide diversity in its uses, hard vulcanized fiber is furnished in several standard grades as well as in special grades developed to meet specific requirements. Up to $\frac{1}{2}$ in. the gray color, which is the most popular, is obtainable in a relatively soft grade, a medium hard grade, and a very hard grade. The latter, known to the trade as "supergray" or "bone-hard," is especially recommended for all difficult machining operations as well as for applications in which its extra strength, stiffness, and hardness are desirable. It has a specific gravity of approximately 1.4, as compared to a range of from 1.1 to 1.4 for the softer grades in these thicknesses.



ARMITE, a vulcanized fiber "fish paper," is furnished in the forms shown and is used widely in electrical parts

It is more difficult to produce vulcanized fiber in heavier thicknesses up to $2\frac{1}{4}$ in., for instance, except by making it softer. The specific gravity of fiber more than 1 in. thick, therefore, usually runs around 1.1, which is lower than that of resinoid materials.

Hard vulcanized fiber adjusts its moisture content to from 5 to 8 per cent in weight. If stored in a relatively dry place for an extended period of time, its moisture content decreases and the fiber becomes more brittle and less satisfactory for punching or machining. Nearly all of the complaints about brittle fiber come in the winter season when the fiber is stored in closed heated rooms. For best results, hard vulcanized fiber should be stored in a relative humidity of from 50 to 60 per cent.

GROWTH of the electrical industry has benefited the hard vulcanized fiber business, since this fiber is approved by the Underwriters' Laboratories for electrical insulation with the one restriction that it cannot be used as the sole support of a current-carrying part. Because it is relatively cheap and can be machined or formed into various shapes in which strength, toughness, and permanence are desirable, it is commonly selected by engineers seeking an electrical insulator. It is widely used, for instance, as switch bars, terminal blocks, insulating washers, and similar parts. For the convenience of those who prefer to buy such parts ready-fabricated, many branch factories located in the principal cities are thoroughly equipped to punch and fabricate special shaped pieces to order.

Hard vulcanized fiber is also extensively used, particu-

Physical Properties of Hard Vulcanized Fiber

Ultimate tensile strength, with grain $\frac{1}{8}$ in. Super-Gray	16,000 to 17,000 psi
Ultimate tensile strength, with grain $\frac{1}{8}$ in. Regular Red Gray Black	13,000 to 15,000 psi
Ultimate tensile strength against grain $\frac{1}{8}$ in. Super Gray	9,500 to 10,500 psi
Ultimate tensile strength against grain $\frac{1}{8}$ in. Regular Red Gray Black	7,000 to 9,000 psi
Yield point is about 60 per cent of ultimate strength	
Ultimate transverse strength against grain	16,000 to 25,750 psi
Ultimate transverse strength with grain	21,400 to 29,500 psi
Ultimate shearing strength $\frac{1}{16}$ in. to $\frac{3}{16}$ in. sheet	9,680 to 12,880 psi
Compressive strength perpendicular to laminations	27,100 to 38,600 psi
Compressive strength parallel to laminations	8,200 to 10,830 psi
Dielectric strength $\frac{1}{32}$ in. sheet	375 volts per mil
Dielectric strength $\frac{1}{8}$ in. sheet	275 volts per mil
Dielectric strength 1 in. sheet	100 volts per mil
Specific gravity up to $\frac{1}{2}$ in. sheet	1.2 to 1.5

larly in the electrical industry, in a special thin grade commonly known as "fish paper." Until within the last year the grades of fish paper on the market were too readily susceptible to mechanical puncture as, for instance, on the sharp projections in the slot when a coil is driven home, and too weak electrically, particularly in their weakest spots. Although this weakness was recognized several years ago, it took two or three years of continuous research to develop the present grade known as Armite, which can be manufactured consistently with uniform high dielectric strength combined with high mechanical strength.

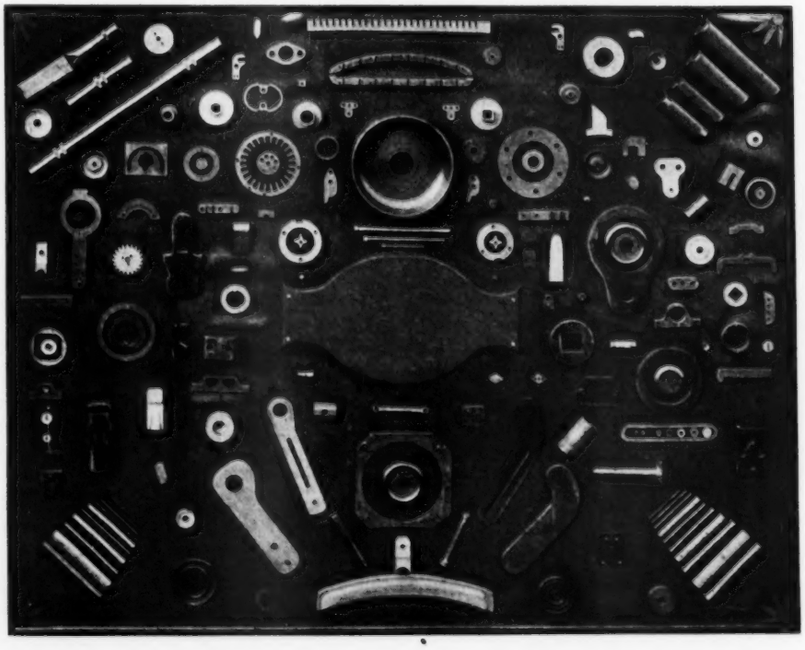
Armite has a dielectric strength averaging above 500 volts per mil. The same material shows a Mullen strength averaging more than 20 points per mil thickness, in the thicknesses commonly used for slot insulation, and possesses that springiness which makes it satisfactory for use as slot insulation when employed in such applications as in automatic machines for winding armatures.

Armite is admirably adapted, not only for slot insulation, but for core insulation in transformers, for lining metal transformer boxes, and for countless other applications in which a thin, inexpensive insulation is required. It is furnished in rolls or coils as well as in sheets and strips.

Aside from the uses already mentioned, hard vulcanized fiber is employed for the following among many other parts: vacuum cleaner parts; washers and gaskets for packing and insulation; bushings and journals; rollers for casters; gear blanks and truck wheels; fuse and flashlight tubes; a great variety of electrical parts; friction disks and blocks; knife and other handles; megaphones and mutes; and parts for sporting goods, pianos, textile machines, cash carriers, and novelties.

This material can be drilled, threaded, turned, punched, polished, sheared, and formed. It can be drawn and formed in dies similar to those used for metal, but for extensive forming or bending it requires preliminary softening by soaking in water and the work must be done in a steam press. Sheets and strips are available in thicknesses from 0.005 in. up to 2 in. or over and round rods in diameters from 0.006 to 2 in. or over. The weight averages about 0.8 oz. per cu.in., but varies slightly as between sheets of different thickness, the thinner sheets being somewhat more dense, and consequently weighing slightly more per unit of volume.

Physical properties of vulcanized hard fiber are summarized in an accompanying table. Immersion in water for one hour results in absorption increasing weight from about 7 to 12 per cent depending upon water temperature, but immersion in lubricating oil or gasoline produces little if any absorption or change in volume. The material is resistant to many chemicals, including weak acids, alkali and salt solutions, but concentrated acids have a destructive effect upon it. It is readily seen that this material has many applications in both mechanical and electrical products.



Vulcanized fiber is used in many industries in which tubular, stamped, formed, turned and milled parts of light weight or good dielectric qualities are required

✦

IMPROVED METALS
Affect All Products

Some design sidelights by men on the observation lines

Chemical Industry Started the Stainless Steel Age

S. D. KIRKPATRICK
Editor, Chemical and Metallurgical Engineering

WHEN the duPont company in 1926 decided to build its first synthetic nitric acid plant entirely of high chromium-iron alloys, it set in motion the impressive development of stainless steel that has since spread to practically every metal-using industry. The equipment of this plant called for 200 tons of alloy—a then unheard of quantity. Yet three years later, in 1929, production of stainless steel had reached an annual capacity estimated at 20,000 tons. Today it is even higher.

Following this successful pioneer work practically the entire nitric acid industry changed over to the new basis. More than 7,500 tons of chromium-iron alloys, representing an investment in excess of $7,500,000 has since been used in the catalytic converters, absorption towers, tanks, and accessories of this one chemical industry.

In the production of synthetic ammonia high pressures and temperatures as well as chemical corrosion are encountered, and it was necessary to look for other alloys of high strength and favorable fabricating qualities. The chrome-nickel steels were largely used at first. During the past year the chrome-vanadium alloys have found wider application, particularly for the catalysts chambers. A measure of the current importance of nitrogen fixation may be seen in the fact that during the past year the plant at Hopewell, Va., the largest in the United States, is being doubled in capacity with an estimated expenditure of $18,000,000. The United States is today independent, even for war requirements, of any foreign source of nitrogen. Much of this progress depended upon equipment designs incorporating the new alloys.

The annual corrosion bill of the American oil industry has been estimated at $135,000,000—a levy of 1 cent on each gallon of gasoline produced in this country. Temperatures and pressures have been constantly mounting in oil refining. Where ten years ago pressures seldom exceeded 100 lb. per sq.in., today cracking stills operate at 750 to 1,000 lb., with temperatures approximating 1,000 deg. F. This development has been made possible largely because of improvements in materials of construction. Tubes and cracking coils of "18-8" (18 per cent chromium, 8 per cent nickel) have been found to stand up longer under heat and pressure than any materials formerly used.

The most recent development in this industry, catalytic hydrogenation of petroleum under pressures in excess of 200 atmospheres and at temperatures of 750 to 950 deg. F., promises a revolutionary advance, and even larger use of special alloys. In the equipment of the first commercial plant now being put into operation at Bayway, N. J., some of the largest ingot forgings ever made of alloy steel are being used. The handling of hydrogen and the hot gases under such pressures and temperatures is in itself a most difficult problem. It has only been solved through the use of superior construction materials.

In sulphite paper pulp production, where corrosion liquors are employed under unusually severe conditions, chromium-nickel-iron alloys are being largely used in digesters and auxiliary equipment, such as pumps, valves and piping. In fact, this material comes nearer to solving the most troublesome problems of the sulphite mill than any metal or alloy available in recent years.

The handling of acid mine waters in the coal field is another important problem solved through the use of chromium irons. Mine pumps of this material have been giving satisfactory service for several years in locations where bronze pumps failed after only three or four months. Because of superior resistance to the milder acids present in fruits and vegetables stainless steel has been widely used in canning and preserving machinery and in dairy and milk-handling equipment.

High Strength-Weight Ratios Turn Airplane Designers Toward Metals

LESLIE E. NEVILLE
Technical Editor, Aviation

DURING the past year, there has been a constant increase in the use of metals in aircraft construction. In recent months, at least two manufacturers noted for their advanced methods of wood construction, have turned their attention to metal work and are building airplanes with structures employing a greater proportion of metal than any of their previous models.

Because of the exacting requirements of aircraft construction resulting from the necessity of maintaining high strength-weight ratios, attention has been focused on the light alloys of aluminum and magnesium. Acceptance of welded steel tubing for the fuselage structures of the major-

ity of airplanes belongs properly to a period previous to the past year. Several American companies have been engaged in work with stainless steel which has many desirable properties as an aircraft structural material but has the disadvantage that it is difficult to work.

Considerable use is being made of some of the alloys of magnesium, such as Dowmetal, which can be welded by means of an acetylene flame or the electric spot and seam welding processes, without recourse to any highly specialized welding technique. On the basis of tests made at the Bureau of Standards, the corrosion resistance of magnesium alloy appears to be decidely lower than that of the aluminum alloy. Although the work has not progressed very far, it has been found necessary that magnesium alloys be protected by coatings, but no thoroughly reliable method has yet been discovered in the research work done in this field.

The most satisfactory protective coating for aluminum alloy sheets thus far discovered is pure aluminum. Even under the combined influence of corrosion and repeated flexure, the pure aluminum coated alloy is greatly superior to the ordinary product. This material is available under the trade name of Alclad. A series of tests to determine the flexural fatigue resistance of this material has been made and the results indicate that the corroded Alclad specimens have approximately the same life as the uncorroded specimens.

A most promising development for aeronautical use is beryllium, a metallic element somewhat similar to aluminum and magnesium, but differing from each of these. Beryllium is ideally adapted to aeronautical work in practically all of its physical properties except ductility. There are, however, certain light structural alloys of beryllium and aluminum containing up to about 60% of the former and reported to have a tensile strength of 80,000 lb. per sq.in. or higher. This metal is still expensive, although research is rapidly decreasing the price.

A careful study of the strength of welded steel tube joints is being made in several quarters and at the moment, it seems probable that electric welded alloy-steel will come into more general use in aircraft construction. One manufacturer has been very successful with this process to date and a number of the others are showing interest in it.

Pressed Steel And Aluminum For Bus Bodies And Chassis

EARL F. THEISINGER
Technical Editor,
Bus Transportation

MOTOR bus manufacturers are beginning to recognize the great economies that can be effected through the use of the increasingly broad range of new metals that are now available. Strength and shock resistance no longer are associated solely with steel and iron, and neither is aluminum and its alloys the sole means of reducing weight.

It is not surprising therefore, that certain parts formerly made of cast iron and cast steel are now made of aluminum while certain other parts that because of lightness were formerly made of aluminum are now fabricated from pressed steel.

Then again, in common with the aviation industry, the bus designer has been able to go to all-metal construction, particularly in the bus body, thus doing away with the need for excessive weight brought about by the use of wooden frame members.

Within the past three years, no less than a half dozen companies have brought out all-metal bus bodies. In thus eliminating wooden members, weight has been reduced anywhere from a few hundred up to a thousand pounds or more. Where formerly heavy wooden box construction was employed, light-weight steel skeletons are now successfully substituted. In the all-metal bodies, frames are usually of fabricated steel, riveted and welded into a rigid and practically weave-proof skeleton. Side panels are usually of aluminum, or aluminum and steel combination. Certain designers prefer the use of sheet steel lower panels for strength and aluminum upper panels for lightness.

In the chassis, practice follows rather generally that adopted in the automotive industry, namely, the use of materials recommended by the Society of Automotive Engineers. This is particularly true of chassis frames, springs, and axles.

Neither has the bus engine been neglected. Interesting from the standpoint of efficiency and economy is the very general use of material designed to withstand better the severe demands required in the modern bus power plant. Nine out of ten present day engine exhaust valves are of the new chrome-silicon alloys, thus doing away with much of the former trouble from burning, warping, and pitting. The use of salt cooled valves to promote more rapid dissipation of heat from valve heads is noted on several engines.

Practically all cylinder blocks are now nickel iron; pistons are special cast iron in two out of three engines. In a number of instances these compare favorably in weight with aluminum design. Where pistons are aluminum or aluminum alloy they are generally of the slotted or clearance type, designed to permit close fit, even when cold and thus help to prevent compression losses.

In engine bearing construction a number of makers are now using steel-back bearings for which longer life and less need for replacement are claimed. One or two other makers use a "chocolate" bearing made of 70 per cent copper and 30 per cent lead. This composition is claimed not to score the crankshaft even if the engine should run for a time without oil.

Strength and Wear Resistance Demanded in Construction Machinery

WALDO G. BOWMAN
Technical Editor,
Engineering News-Record

IN CONSTRUCTION machinery speed and stamina are repuired to a greater degree every year, and these necessitate the use of better materials. For heavy, sturdy parts, cast steel has been substituted for cast iron. Where light weight is desirable structural steel frames, riveted or welded, are the rule. Toughness and resistance to abrasion are being secured by the use of nickel and manganese steels. Anti-friction bearings of special-analysis steels, and alloy-steel silent chains are becoming more common. Bronze bearings prove effective for low-speed shafts on high duty.

Some examples of the materials used in this year's construction machinery will show the present status of its engineering design:

Cast-steel frames are used for the wheel carriages of heavy trailers that transport power shovels and tractors. Steel base castings are also used to support paving mixers. Both the lower and upper frames of backfiller cranes are made in one-piece electric

steel castings. The upper and lower frames of power shovels and back fillers are also unit steel castings. One representative clamshell bucket utilizes steel castings for the head, corner brackets, and hinges. Suction dredges, which represent a high-duty type of construction equipment are being fitted with alloy-steel castings in the suction lines, head, trunnions, and pumps. Copper-bearing steels are being incorporated into the floats of the pontoon lines as a protection against corrosion, and rubber linings are being used effectively in the pumps. Bronze impellers are used in nearly all centrifugal pumps.

One trolley hoist has Aramite metal to replace cast iron in the frame. Castings of this metal have twice the tensile strength of gray iron and will withstand considerable shock. The rings of the giant concrete mixer used on the Owyhee Dam were of cast iron 4½ in. in thickness, 18 in. in width, and 110 in. in diameter. The steel drum for this mixer is lined with a layer of Davis process hard-steel surfacing applied by the electric arc This lining was designed to last for the entire job.

Screens for vibrators are now made of manganese-steel wire or of other special steel wires. Cast gears, until recently common in construction machinery are now entirely replaced by cut steel gears, these often being usually of chrome-nickel steels. The hoist shaft of one of the most advanced designs of paving mixers is of chrome-manganese steel which is very tough, hard, and resistant to shock. The driving shafts are of chrome-nickel steel.

Weight saving is not always important in construction machinery, but where desirable it is taken care of by the use of alloy steels. Actually, sizes of machines are being reduced by the use of these steels for frames, stressed parts, gears, and shafts. Rock crushers employ high-manganese steel castings for the entire frame where formerly only the jaws were of this material. Removable steel crawlers on motor trucks are of chrome-nickel-molybdenum steel, while treads of crawlers used on other equipment are likely to be of manganese steel. Hardened steel bushings are used in the shoe hinges of these crawler units. Even a casual survey of the present-day piece of construction equipment will indicate that designers of these products are alive to the advances in new materials and alloys and are incorporating them into their latest designs.

High-Tensile Steels And Special Alloys For Power Equipment

A. D. Blake
Managing Editor, Power

MATERIALS employed in the construction of power plant equipment, in general, have to satisfy conditions of strength, temperatures, and resistance to corrosion and erosion. Up to the present, steam practice in this country has held to temperature limits of 750 to 775 deg. F., with a trend toward increasing pressures. In the strife for still greater efficiency in the steam cycle, however, the urge, of late, has been toward higher temperatures. One plant, of a more or less experimental nature, but operating on commercial load, is about to go into service at 1,000 deg. F. High temperatures concern principally superheaters, piping, valves, fittings and turbine blading.

Low- and moderate-pressure riveted boiler drums are made of fire-box or flanged steel, having an ultimate strength of 55,000 to 65,000 lb. per sq.in. and drums carrying from 1,200 to 1,400 lb. pressure are forged from the solid ingot of steel having a tensile strength of 60,000 to 75,000 lb. per sq.in. and a carbon content of 0.35 to 0.45 per cent.

Low-carbon steels have been found generally satisfactory for superheaters under existing pressures and temperatures. They have the advantage of being easily worked. For higher temperatures chrome-nickel and Calorized steel offer possibilities. The last named has been extensively employed in oil-still work and has the advantage of being immune from oxidation.

Many of the high-strength alloy steels are unsuitable for boiler work because they are deficient in ductility. Moreover, some have an advantage in strength over carbon steel at moderate temperatures only. They are finding their greatest application in valve fittings, turbine blading, fan blades, and pump impellers, where their resistance to erosion and corrosion are important factors. Nickel-chromium steels and nitrided steels are being used extensively for valve fittings.

Turbine blades have to withstand not only erosion but also centrifugal stresses and vibration. It has been found difficult to get materials that will meet all these requirements, and only a few have been found to withstand present-day hard usage. Manganese-copper and manganese-bronze have given satisfaction for blades subject to low stress and Monel for medium stresses, whereas stainless steels and nickel-chromium steels are widely used for blading subject to high stress, with the exception of the last stage wheels, where nickel is employed to resist the high mechanical stresses incident to the long blading.

Alloy steels are employed to some extent for the tips of fan blades where the air or gases handled are laden with abrasive material. But, because of the expense involved, renewable plates of low-carbon steel are still largely used. Monel metal finds wide use in pump impellers, where it is necessary to resist corrosion. Hydraulic Bronze has not been found to stand up well under high-pressure and high-temperature water.

Electric Railway Cars Go to Aluminum

Morris Buck
Engineering Editor, Electric Railway Journal

FACED with the problem of reducing operating expenses to a minimum while bettering equipment, the electric railway industry has directed much of its effort toward selecting materials for the reduction of weight without sacrificing strength. Among the more important results of light weight are less power consumption, smaller motors and other parts, higher acceleration, easier braking, less wear on the track structure, reduced wear of brakes, and less noise.

For a number of years metal gradually has been displacing wood in the construction of electric railway cars. With the heavy service demands of today it is necessary to use as nearly 100 per cent metal frame as possible. Real strides have been made in the use of pressed and formed metal framing and structural members in building modern cars.

An outstanding trend in car materials is that toward the use of composition roofing, paneling and flooring. Several high-grade trade products, such as Haskelite, Plymetl, Agasote, Flexolith, and Tucolith are being used extensively as standard materials in many cars. Light weight

CONTINUED ON PAGE 433

CONE PULLEY DESIGN

Calculations for Open and Crossed Belt Types

By WILFRED E. JOHNSON

Oregon State College

PROBLEMS in designing a set of cone pulleys divide themselves quite naturally into two general classes: (1) Open belt and (2) crossed belt. If the design is such that a crossed belt is to be used, the problem is simple. It can be shown that for a crossed belt, the length of belt will be constant if the sums of the diameters of the corresponding steps be kept constant. Hence, knowing the diameters of one pair of steps, and the successive speed ratios desired, we have, for crossed belts, the two equations:

$$R/r = \phi \qquad (1)$$

$$R + r = C \qquad (2)$$

In these equations

ϕ is the speed ratio
R is the radius of the larger step on one of the pulleys
r is the radius of the smaller step on the other pulley
C is a constant quantity.

The above equations can be solved simultaneously for the successive radii. A proof for this method will be given later.

If the design requires an open belt, it can be shown that the angularity of the belt is a factor which makes the sum of the diameters of the corresponding steps a variable quantity. The equations used for crossed belts therefore cannot be applied for open belts.

It can also be shown that if an equation be derived for successive radii of the steps of a cone pulley, using an open belt, this equation will be so involved that it will not be possible to solve it directly. A direct solution, however, can be made for the length of the belt.

Let D = Distance between pulley centers, inches
R = Radius of large pulley, inches
r = Radius of small pulley, inches
K = Length of belt, inches.

Then

$$K = 2\sqrt{D^2 - (R - r)^2} + \pi(R + r) + 2(R - r)\sin^{-1}\frac{R - r}{D} \qquad (3)$$

Where the distance between centers is comparatively great, and the pulleys are of nearly the same diameter, the third term on the right side of the equation may be omitted. It will be noted that if the pulleys are of the same diameter the third term in the above equation is equal to zero.

Because of the impossibility of securing a direct mathematical solution for successive radii, many graphical methods have been developed, together with some approximate mathematical solutions.

The idea of using a permanent chart for the solution of cone pulleys with open belts, although original with this author, is probably not new. However, to the author's knowledge, the permanent chart method has never been used. From equation 3 it is seen that the general equation for the length of belt contains four variables. This precludes the use of permanent charts unless one of the variables can be eliminated. The four variables are:

K, the length of belt
R, the radius of large pulley
r, the radius of small pulley
D, the distance between pulley centers.

Of these, the first three maintain a constant ratio to D in any given problem, that is, D can be taken as unity. Thus, the other three variables will be proportionately reduced, and to obtain the actual value of these variables, it is only necessary to take the value of the variable at $D = 1$, and multiply it by the actual value of D. This is equivalent to making the distance D the unit of measurement.

A chart may now be plotted which gives the value of K for any combination of R and r.

Let $\frac{K}{r} = \phi$, the speed ratio.

Then it is convenient to plot K as a function of ϕ and r. Since for any pair of real values of ϕ and r there exists a value of K, the area of such a chart represents an infinite number of values of K.

It is necessary, then, to plot a large number of curves to obtain the required accuracy. Herewith is shown a general chart of this nature. The value of ϕ varies between 1 and 10. This is a liberal range, as the value of ϕ rarely exceeds 3 or 4 in the majority of designs. The values of r, are plotted as ordinates. As D is the unit of measurement, the value of r as plotted is taken as $\frac{r}{D}$, and will therefore vary between zero and the value of $\frac{r}{D}$ at which the two pulleys would be touching each other at the speed ratio under consideration. This limiting value is given by the relationship that

$$r + R = D$$
$$r(1 + \phi) = D$$
$$\frac{r}{D} = \frac{1}{1 + \phi}$$

This gives the practical upper limit of $\frac{r}{D}$. For the speed ratio, ϕ, it is not necessary to plot values less than 1, since the reciprocal of ϕ may be used in conjunction with the mating pulley.

In order to obtain values for plotting the chart shown in the accompanying figure, a series of values of ϕ are taken, starting with 1 and increasing by some convenient increment, such as 0.5. For each value of ϕ, a series of values are chosen for $\frac{r}{D}$, such as 0.02, 0.04, 0.06, increasing up to the limiting value of $\frac{r}{D} = \frac{1}{1 + \phi}$. It must be remembered the D equals unity in all of these equations.

The pairs of selected values for ϕ and $\frac{r}{D}$ are used in an equation to determine the corresponding value of K. Equation 3, given above, could be used for this purpose, but in order to facilitate calculations, it should be put in a more simplified form. This can be done readily by making the following substitutions:

Let $$\sin B = R - r \qquad (4)$$
$$= r\left(\frac{R}{r} - 1\right) = r(\phi - 1)$$

Then
$$\sin^2 B = (R - r)^2$$

But $\sin^2 B + \cos^2 B = 1$
$\cos^2 B = 1 - \sin^2 B$

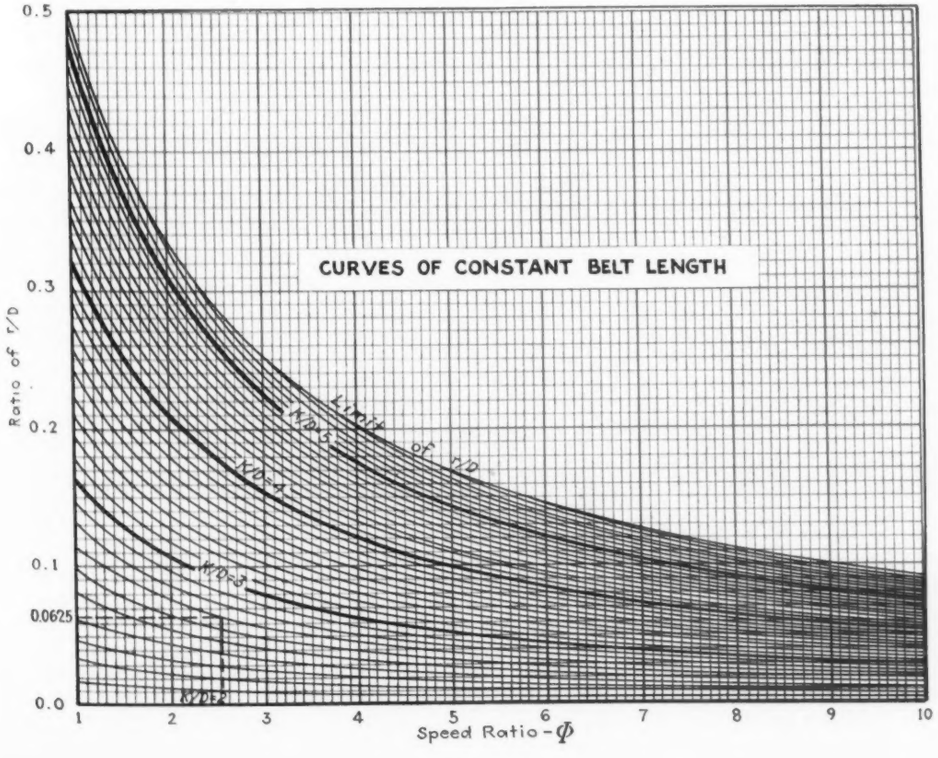
As D or D^2 is equal to unity,
$$\cos^2 B = D^2 - (R - r)^2$$

Hence for the first term in Equation 3, we have:
$$2\sqrt{D^2 - (R - r)^2} = 2\cos B$$

Also, for the second term
$$\pi(R + r) = \pi(R - r + 2r)$$
$$= \pi r\left(\frac{R}{r} - 1 + 2\right)$$
$$= \pi r(\phi + 1)$$

For the last term of Equation 3, we get from Equation 4:
$$\sin B = R - r$$
$$= \frac{R - r}{D}, \text{ as } D \text{ equals unity}$$

Hence
$$B = \sin^{-1}\frac{R - r}{D} \qquad (5)$$



✦

A permanent chart can be used for the solution of cone pulleys having open belts. The author describes how he arrives at solutions

We also have

$$R - r = r(\phi - 1) \qquad (6)$$

Substituting Equations 5 and 6 in the last term of Equation 3,

$$3(R-r)\sin^{-1}\frac{R-r}{D} = 2r(\phi-1)B$$

Equation 3 then becomes:

$$K = 2\cos B + \pi r(\phi+1) + 2r(\phi-1)B \qquad (7)$$

wherein $\cos B = \sin^{-1} r(\phi - 1)$.

Substituting the selected pairs of values of ϕ and r or $\frac{r}{D}$, in Equation 7, the corresponding value of K can readily be calculated, these quantities in reality being equal to $\frac{K}{D}$. The curves, as shown in the accompanying figure, may then be plotted.

The practical application of this chart is best shown by an example.

It is desired to run the drive pulley of a machine at speeds varying between 500 and 100 r.p.m., the countershaft running at 200 r.p.m. There are to be five speeds and they are to be in geometric progression, that is, each succeeding speed is to be equal to the preceding speed times a fixed quantity. The smallest pulley on either of the cones is to be 6 in. and not less. The distance between the pulley centers is 48 in. The diameters of the steps of the pulleys are required.

As there will be five speeds, such as n, xn, x^2n, x^3n and x^4n, and the highest speed, x^4n, is to be 5 times the lowest speed, n, then $x^4 = 5$, or x, the constant multiplier for the successive speed ratio will be:

$$x = \sqrt[4]{5} = 1.495$$

The smallest speed ratio will be 100 divided by 200, or 0.5.

Let a, b, c, d and e represent the radii of the steps of one pulley, and a', b', c', d' and e' the radii of the corresponding steps on the other pulley, and ϕ_1, ϕ_2, ϕ_3, ϕ_4 and ϕ_5 the corresponding speed ratios. Then proceeding from the lowest to the highest speed ratio, and using the common multiplying factor, 1.495, as calculated above, we have

$$\phi_5 = \frac{e}{e'} = 100 = 0.500$$

$$\phi_4 = \frac{d}{d'} = 0.5 \times 1.495 = 0.748$$

$$\phi_3 = \frac{c}{c'} = 0.7475 \times 1.495 = 1.118$$

$$\phi_2 = \frac{b}{b'} = 1.118 \times 1.495 = 1.672$$

$$\phi_1 = \frac{a}{a'} = 1.672 \times 1.495 = 2.500$$

As the smallest diameter pulley is to be 6 in., or of 3-in. radius and the distance between shafts, D, is 48 in., we have, $\frac{r}{D} = \frac{3}{48} = 0.0625$. At the intersection of the horizontal and vertical lines representing $\frac{r}{D} = 0.0625$ and $\phi = 2.50$, we have the curve of constant belt length $\frac{K}{D} = 2.7$. Following along this curve we get for:

$$\frac{b}{b'} = \phi_2 = 1.672 \qquad \frac{r}{D} = 0.083$$

$$\frac{c}{c'} = \phi_3 = 1.118 \qquad \frac{r}{D} = 0.105$$

$$\frac{d'}{d} = \frac{1}{\phi_4} = \frac{1}{0.748} = 1.335 \qquad \frac{r}{D} = 0.095$$

$$\frac{e'}{e} = \frac{1}{\phi_5} = \frac{1}{0.500} = 2 \qquad \frac{r}{D} = 0.073$$

It will be observed that for ϕ_4 and ϕ_5, the reciprocal of the speed ratio was taken. This is necessary, as the chart does not go below a speed ratio of 1, and is permissible as the speed ratio may be expressed either as ratio of driver speed to driven, or vise versa.

To obtain the actual value of the radii, the above values of $\frac{r}{D}$ must be multiplied by 48 in., the distance between pulley centers. The corresponding radii on the other cone are found by multiplying by the required speed ratio. Thus:

$a = 3$ in. (specified) $a' = 3 \times 2.5 = 7.5$ in.
$b = 0.083 \times 48 = 3.984$ in.
$c = 0.105 \times 48 = 5.040$ in.
$d' = 0.095 \times 48 = 4.560$ in.
$e' = 0.073 \times 48 = 3.504$ in.

The above radii, when multiplied by 2, give the diameters, and when these latter are multiplied by their pertainiing speed ratio, the corresponding diameters are obtained. The diameters of the two cone pulleys may be tabulated as follows:

Step	Diameter of Driving Pulley	Diameter of Driven Pulley
A	$2 \times 3 = 6$	$6.00 \times 2.5 = 15$
B	$2 \times 3.984 = 7.97$	$7.96 \times 1.672 = 13.32$
C	$2 \times 5.040 = 10.08$	$10.08 \times 1.118 = 11.27$
D	$9.12 \times 1.335 = 12.17$	$4.56 \times 2 = 9.12$
E	$7.01 \times 2 = 14.02$	$3.504 \times 2 = 7.01$

The diameter of the smallest step on the driven pulley is more than 6 in. If it had figured less than 6 in., the specified minimum, it would have been necessary to recalculate, starting with the assumption that this diameter is equal to 6 inches.

The length of belt required for this pair of stepped cone pulleys, 48 in. between centers, is calculated from

$$\frac{K}{D} = 2.7$$

$K = 2.7 \times 48 = 129.6$ in. (length of belt)

The diameters of the steps of the cone pulleys as calculated above are based on a belt of zero thickness. To correct for this, each step should have subtracted from its diameter a namount equal to 0.8 times the thickness of the belt. This is a practical value which has been found to put the center line of the belt very near to the correct velocity line.

[Editor's Note] The reference book sheet of a forthcoming number of *Product Engineering* will set forth two enlarged belt charts of the type described in this article.

THE PRODUCT NEEDS COLOR

Mr. Ellis, Art Department, Carnegie Tech, and Mr. Sinclair, Art Department, Westinghouse, discuss color application and form on a new electric locomotive

By D. R. DOHNER

Art Director,
Westinghouse Electric & Manufacturing Company

AMONG a host of reasons for the gradual creep of color into industrial products, several stand out: The ability of color to attract attention; its power to stimulate an emotional reaction, thereby creating desire; and pure aesthetics.

Prior to the last few years color was used in industry chiefly to serve some utilitarian purpose such as identification and standardization. Once a certain wagon was identified by its color and trimmings, whereas now the green liquid—or perhaps it is orange—distinguishes one's favorite brand of gasoline.

The use of color as a means of identification and standardization has gradually made industry "color conscious" and has shown the tremendous strength of color in attracting attention. Advertisers were perhaps the first to sense this. While the effect in many cases was unfavorable and disappointing—witness the gaudy, bizarre billboards and signs—yet, color usage improved and the present advertisement is colorful, charming, delightful, and often forceful.

The manufacturer did little better at first. Hideous, raw color combinations among motor cars emerged from the "buggy color" stage. Such relationships had little power to stimulate a favorable reaction or stir the aesthetic environs. But they did attract attention. Many manufacturers are still misled on this score. Each one craves individuality and distinction, and in straining for it many produce mediocre results. This accounts for the fact that certain well-known motor cars of quality, full of individuality but poor in relationship of form and color, finally were forced to sacrifice some of this precious quality for better appearance.

So long as color is used primarily to attract attention it will be a mere novelty. As such it is surely bound to pass. It is in the field of the aesthetic, heretofore practically untouched, that color has its greatest potentialities, but only when used knowingly and with discrimination.

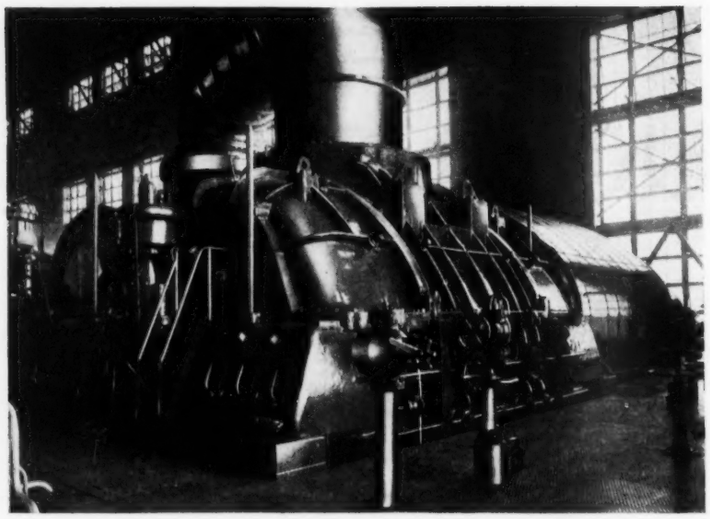
Color is a powerful drug. It excites and stimulates, it depresses, it soothes, it makes possible sparkling, brilliant, scintillating effects, it wraps its veil about sordid and unrelated things and lifts them to a noble estate. Color can create a feeling of weakness or a feeling of strength. At times it is sweet, pretty, soft spoken, effeminate. On the other hand it may be virile, masculine, brutal, austere. In short, color can delight and entertain, can stimulate and create a desire. There is the opportunity for the manufacturer to use these powers to advantage.

Color means something more than the few primary and secondary hues of the spectrum. It has three properties or dimensions, namely, hue (the name, as red, yellow, or blue); value, (the amount of light reflected, as light red or dark blue); and chroma, (the intensity or brilliancy, as a bright orange or a gray green).

In color as in design or any organized work, the success of its use depends upon achieving the maximum amount of variety with unity. When it is realized that from 3,000 to 5,000 hues can be distinguished by the average person, each with many values and changes of chroma, then the infinite variety of these properties can be more readily appreciated.

If more people understood the vast possibilities of changes in these properties and appreciated their control, not looking upon the pure red and blue of a label as an honest attempt at color relationship, better results could be obtained. No doubt the vogue of using a trade name for some particular value and chroma of a familiar hue has done much to undermine the attempt to understand the control of color properties, which in turn affects color relationship.

Hues give the effect of warmth or coolness, advancing and retiring, each speaking a separate language. Red will say most emphatically what blue never can; it is difficult to imagine a red refrigerator as satisfactory as a green or blue-green one. A tint of violet would make a



TURBINE GENERATOR, designed for the Hell Gate Station, finished in dark green to harmonize with the station's interior. Other machines are often colored to harmonize with shop interiors

locomotive appear weak and effeminate. You smile, but are not "boudoir-colored" motors-cars seen every day? About us continually are utilitarian machines of transportation with color effects that are nothing short of "arty".

The values of a hue give a sense of light and dark, and therefore of pattern. When the values are widely separated strong contrast is obtained and one object or section stands apart from another, whereas when the values are close the edges merge and become lost regardless of the change in hue or chroma. This quality of color is most valuable to the artist and to the manufacturer.

In a meter or clock, for instance, it may be advantageous to emphasize an interesting and integral part of the mechanism against a widely separated background. Or it may be necessary to bring two or more parts close together in value, thereby fusing them into one.

The value of a hue is raised by adding white and lowered by adding black. An important thing to remember is: As the value of a hue is changed, so automatically is the chroma weakened. In other words, as a red is raised or lowered in value it becomes neutralized to a certain extent. As the cool hues are changed they become warmer, the warm hues cooler. The various hues at full chroma come at different value levels. Yellow, full chroma (in other words, pure yellow) is very light and comes at value 80, 90 being white in the Munsell scale, while a pure red is value 40, black being 10.

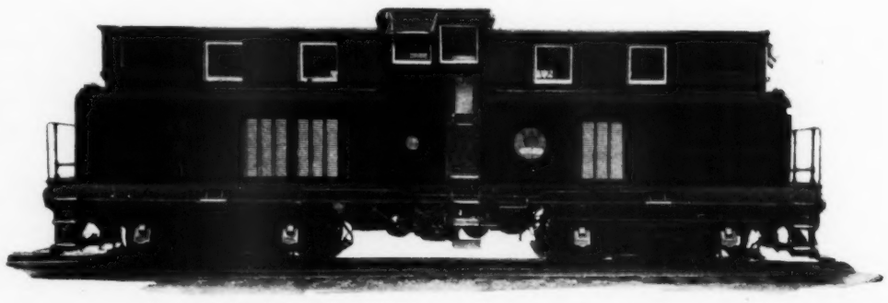
A REVERSAL of the natural order of color values is a most common cause of unpleasant color relationship. A reversal of the natural order should be used either in small areas or for the purpose of emphasis. In painted furniture dark greens are often used with light violet, light blues, and dark yellows or oranges. A lavender (violet raised in value) bathroom trimmed in green which would probably be lower in value merely emphasizes the weakness and insipid qualities of a purple so far removed from "home." Likewise many linoleum and textile patterns are weakened through the ignorant use of poorly related and reversed color values.

Where light values are required or thought necessary together with some chroma, then lines coming higher in value (yellows, yellow - oranges, oranges, greens and yellow-greens) give the most pleasant effects. For deep, rich effects the lower valued hues (reds, blues, purples) are best.

The chromas of a hue vary in number, (red being the most chromatic) and are the steps or variations from a pure pigment to a neutral gray, both up and down the value scale from white to black. Within this range lie many, many possibilities of pulling together otherwise unrelated hues, making for a unity of color. The chromas are changed by adding a neutral gray or a complement of the hue. Chromas of a hue may be changed without altering its value.

How can this knowledge be applied to everyday work? To begin with, color is very illusive and not the standard appearing thing most people believe it to be. The appearance of a color is, to a large extent, dependent on its surroundings. When colors of different hues are brought together, the effect is to move them farther apart in hue. If, for example, a red is next to a yellow, the red will appear purplish, the yellow greenish. Strongly contrasting hues—that is, complementary ones—are incapable of further change in that dimension. Accordingly, when complements are associated, the only way they can be moved farther apart is by making them appear more chromatic or intense.

IF a red and a green are placed side by side, each makes the other appear more brilliant. The more nearly similar in hue two colors are the more they seem to change with respect to hue when put together. If a yellow-orange and an orange are closely associated, the yellow-orange will appear more yellowish, the orange more reddish. In general the effect of contrast is much more ap-



BALDWIN Westinghouse locomotive, a result of careful color treatment. Strong horizontal bands make the locomotive appear longer and lower. The dominant color of the original is olive drab

parent in colors of reduced chroma than otherwise. In producing strong effects of contrast it is necessary that the active color should have an area larger than the one to be acted upon.

When colors which differ only in chroma (intensity) are brought together, the less chromatic one suffers a further decrease in chroma. If a gray-red of a certain value is placed beside a second gray-red considerably grayer but of the same value, the second red will appear more neutralized. However, in the association of complementary hues of differing chromas, both become more chromatic. For instance, if a brilliant green is associated with a gray-red, both appear more chromatic.

DESIGNED by a commercial artist to harmonize with the customer's product, this motor is an example of the importance one large company gives to appearance in product design

In the home, color creeps gradually from the old red table cloth, or oil cloth, to the utensils, the range, the refrigerator, the cabinet, and the floor covering. Manufacturers, through fear of color and enlarged stocks, have tried to jam down the housekeepers' throats hideous golden-oak cabinets and grayish white sinks. How distinctive if some of these were trimmed in black, how cheerful if combined with color! Much has been made of spotless, white, symbolical of cleanliness, as a suitable finish for all kitchen ware. But who is to slave to keep this equipment spotless? Who is to maintain this "operating room" appearance—a monotonous, glaring effect?

THE hue scheme should be cheerful and cool to give best light values, especially if the room has poor lighting. Since the success of color relationship, mentioned before, depends upon the maximum amount of variety with unity, taking into consideration the usage or fitness of the scheme, great care must be exercised so as not to use too many hues. In other words, the hue scheme should be simplified, variety and pattern being achieved through value and chroma. Hues contrasting with the general scheme can be brilliant if used in small areas. If used in large objects, they should be neutralized to avoid setting up too much competition with the general scheme.

The ordinary office of today is a drab affair. Metal desks and filing cabinets are painted with a dark value of a hue belonging in the upper register, a hue almost impossible to combine with others unless of lower value. When will office furniture be cheerful and restful without being undignified, bizarre, or gaudy?

The industrial plant with its dull and cold blue-gray surroundings is scarcely conducive to enlivened mental reactions. Why is machinery gray? Merely to standardize it and to make it fit in grayer places? This is probably correct, for back of it all is a desire to "play safe." Is there an opportunity here for some machinery manufacturer to break away from tradition and set the style? LaSalle did it several years ago, Cord last year.

Why, if a switchboard must be black, cannot the instruments be in polished or colored metal? How about virile energetic red with black and metals with natural finishes for the huge generator grinding out tremendous energy? The power stations with shining metals lovingly cared for could go a few steps further with the use of color (some have) and make their plants not only attractive but expressive of the energy and efficiency of this engineering age.

When color, wisely used in the smaller industrial products made of wood, metal, porcelain, and the new plastic materials now commercially available, gradually makes itself more widely felt, perhaps then automatic parking stations of the future, great air ports, huge public buildings, all may be enlivened with color.

WHAT a gala day! But a dangerous one, for this great benefactor may be turned into a curse. We cannot but agree with that great modern philosopher, Bertrand Russell, when he says, "Where avoidance of error is the chief thing aimed at, we always produce a bloodless type."

In the final analysis, color is a powerful factor in our lives, a potent drug, sheer magic! It will be little short of calamity if color, through lack of knowledge and understanding, is permitted to become a mere fad, to drop to the cheap, harsh and gaudy level of some of its sponsors and thereby cause a return to the cold gray and black days of our forefathers.

Rather, through a desire for fitness of its usage together with a thorough knowledge of its properties, results above the mediocre can be achieved. The manufacturer who sets out through many tedious and expensive steps to paint metal to imitate wood fails to achieve the end in view.

The widest usage of color can hardly be expected without broad and fundamental training. When manufacturers and industrial leaders realize this, and take advantage of the many trained artists in this country, then and then only will color in industrial products be raised to a higher plane and its great potentialities utilized, to their own and to the public's benefit.

Color for the finish of the product requires relatively as much care and thought as the material that goes into the product. Mr. Dohner has some pointed things to tell the designer in his interesting article

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COMMENT AND SUGGESTION

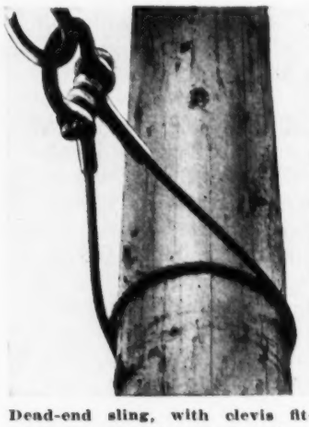
Effective Cable Fastenings

By Albert S. Rairden
Chief Engineer,
American Cable Company, Inc.

IT IS surprising how many applications of short lengths of cable can be found in machines of various types. In the past the chief difficulty in using such lengths lay in making a neat and compact attachment for the cable ends; one that would not loosen under repeated stressing and not injure the cable or affect its strength adversely.

When a cable can be looped back upon itself a clamp can be used, or, when this is not feasible, a socket with a tapered hole into which the cable wires are expanded and held in place by zinc, poured in while molten, can be employed. The first of these arrangements is rather cumbersome and the clamps may weaken the cable or cause abrasion and failure. The second does not lend itself to rapid production and is likely to draw the temper of heat-treated wire, thereby reducing the cable strength.

After considerable experimenting, our company found a neat solution of this problem in the joint shown in the illustrations. This joint is made by flowing or otherwise displacing while cold the metal of a sleeve, clevis, or other similar fitting, so that the metal

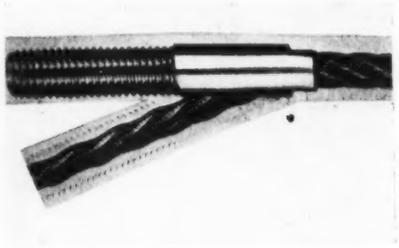


Dead-end sling, with clevis fittings swedged on each end

is forced into the spaces between the strands and individual wires of the cable. The result is a joint as strong as the cable itself; one which is compact, easy to produce in quantity, and wholly reliable.

To date, fittings of this type have been applied extensively in many machine and other parts, the cable varying in length from a few inches, in what amounts to being a flexible bolt for supporting the basket of a centrifuge, up to several feet, as, for example, in the counterpoise cables used on Bullard vertical turret lathes.

Among other applications are those found in road-building machines, brake operating cables on many makes of cars, sash-operating cable, slings for motor-boats, sidewalk elevator cables, water-cooler supports, pulp wood conveyors, dead-end slings for



Tru-Loc fitting cut apart to show how the metal has been cold-flowed into the space between cable strands

support of high-tension power lines, and catenary supporting cables for over-head railway electrification.

At the present time the largest single application of these fittings is in brake control mechanisms for passenger cars. A unit of this type is shown in an accompanying illustration. The tension member is a $\frac{3}{16}$ in. wire cable made up of many rust-proof high-carbon steel wires to which the processed end-fittings are attached. This cable passes through a flexible casing made up of a closely wound spring wire core, surrounded by a multiplicity of wires applied with a coarse pitch with cotton packing between each wire and bound with an outer wire covering.

This flexibility and ability to stand compression solves many of the problems the automotive engineer has in co-ordinating spring deflections, axle caster and steering geometry. It efficiently and neatly replaces mechanisms previously used for brake actuation, and is equally applicable to various other control mechanisms.

Tru-Lay Cable with Tru-Loc fittings fastened to ends and flexible wire sheath comprising the brake controls used on various passenger car chassis

STOP... LOOK... LISTEN...

. IDENTIFICATIONS . . .

ONE of our friends was talking about flexible shaft couplings the other day.

"You know," he said, "couplings are funny things. You'd never think some of them would work at all.

"There's the A coupling, that's put together with hairpins. The B coupling uses razor blades, and the C coupling contains false teeth, while D uses tin pie plates, and E employs garden hose.

"But the real nifty new one is made by F, and uses Nabiscos!"

Sounds odd, but if you think a moment, and know couplings, you can identify every one of them.

. . . GRAVITY DEFIED . . .

THE OLD GAG of the boys about whether or not the knotholes would be left suspended in the air when the fence fell is recalled by a United Press report in the *New York Herald* that when houses fell in the Melfi earthquake "beds, tables, chairs, were suspended in the air." The boys did hve some argument about the holes in the air, but apparently science must have something yet to learn at Melfi, according to "I see by the papers."

. . . PRACTICAL HADES . . .

EVEN the proverbial asbestos cat would have a poor chance in the Westinghouse laboratory, where Dr. J. Slepian has produced a temperature of 900,000 deg. F. by an electric arc in a vacuum. This high temperature was calculated by measuring the velocity of the molecules of the electrode as they "boiled away." Our guess is that it will not be long now before a use is found for such high temperatures in producing materials that will have engineering value.

Why Not Celluloid?

By J. A. Pouch

POWER-DRIVEN lawn mowers are of necessity designed with an eye to saving weight. One manufacturer of these machines provides a unique cover for the housing that protects the reduction gears and auxiliary chain drives. The cover is simply a piece of transparent celluloid.

The use of transparent sheet celluloid as a gear-case cover is not only unusual, but apparently practical as well. It serves the purpose. The required protection is given to the mechanism contained in the gear case; the material is light in weight, enduring, non-corrosive, and will not permit rattle. Also, it is relatively inexpensive and easy to fabricate.

Undoubtedly there are many possibilities for the use of celluloid in construction such as described above or where similar requirements are to be met.

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Die Castings Improve Radio Design

By R. deCola and C. M. Jeffries

Victoreen Radio Company

RADIO receivers, like other delicate electrical devices, requires not only extreme careful electrical design but also requires considerable attention to its mechanical construction. How well any device will work depends very much on how much attention has been paid to its mechanical design. In the case of a radio receiver, although a perfect electrical device might be designed, how well and for how long a time the unit will continue to operate without any attention depends almost entirely upon its mechanical design.

Probably the greatest point in the mechanical design of a radio receiver is the rigidity of the condenser housing. It has been found that unless the greatest precaution is exercised in the careful construction of this housing the condensers when placed in position and bolted down will invariably go "out of line." In the illustration is shown how the Victoreen condenser housing was finally constructed in order that it would not be in the least bent when it was finally bolted down to the lower casting.

Thicker walls were at one time considered in order to increase the rigidity of this housing but it was finally decided and found considerably better to make the casting with

. . . CO-OPERATION AGAIN . . .

SOMETIMES the designer gets credit for pleasing lines that did not flow from his facile pen. There is a motor truck that nearly always attracts attention to its hood because of a sturdiness that indicates power. When the design reached the shop the sheet-metal man threw up his hands; it couldn't be made with his equipment. So they told him to go ahead and do the best he could on the first truck. He fudged up a hood and expected to be called down by the designer. But it was so pleasing and so much better than the original that it is still used.

•

. . . OLD FAITHFUL . . .

WHEN calculating the life of bearing surfaces the designer might study a few automobile figures. According to state license figures for this year, 75 per cent of all Franklin cars built since the company started 28 years ago are still in service. Records indicate that from 100,000 to 300,000 miles is the life of these cars. One, owned and driven since 1918 by an old time plainsman, El Comacocho, who probably hasn't been too gentle with it, has gone 250,000 miles without regrinding the cylinders. Figuring 3,000 revolutions per mile, the pistons have traveled nearly 95,000 miles on the cylinder walls! The cylinders are of nickel cast-iron.

•

. . . CELOTEX GOES AUTOMOTIVE . . .

TO THE long list of automotive materials must be added the name Celotex, for some Fisher bodies now being produced are partly insulated (against heat and noise) by a $\frac{3}{4}$-in. sheet of this material inside the dash. On top of this is a $\frac{1}{2}$-in. layer of felt. Felt-lined mats for front and rear floor coverings also are used.

All of which goes to prove the contention that silent operation is of increasing importance. Also that motorists don't like cold feet, or feet that are too hot, either.

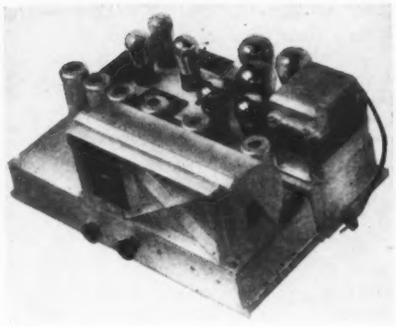
•

. . . CHOOSE YOUR PROPERTIES . . .

ENGINEERING still may be chock full of compromises, but when it comes to material selection the limits are constantly being narrowed in one sense and broadened in another.

Name almost any physical properties desired and some material usually can be found that has 'em; often a wide range is available. So we have metals that are non-corrosive even at extreme temperature; alloys that melt at almost any temperature desired; plastics, earths, and ceramics with exceptional electrical properties; alloys of almost zero coefficient of heat expansion.

Only specialists in material selection can pretend to keep fully abreast of the times, but let the engineer specify the qualities of materials needed, and it's a tough break if he can't get 'em somewhere today.



the cross-sectional bracing as shown. Also difficulty was encountered in the manner and points on which this housing was fastened to the lower tuner casting. Formerly the housing was supported at four points with large bolts, but it was found that this had a decided tendency to bend the casting slightly, which in turn resulted in a considerable twisting of the condensers mounted inside this housing. The new construction shows only three points of support which completely eliminated any twisting formerly encountered.

Four straight-line-frequency variable air condensers are mounted inside the housing. These condensers are constructed of aluminum stock 0.032 in. in thickness which are die cast together. The spacing between each plate in these condensers is only 0.087125 in. and all condensers are pinned to a $\frac{3}{8}$-in. shaft and supported at three points on phosphor bronze bearings. Each condenser, in order to insure proper and correct electrical contact, is equipped with an individual phosphor bronze contact spring.

To insure continued long service of the radio set all coils and condensers are enclosed completely by metal cans. These cans are of nickeled copper. This also insures a unit of very neat appearance. The amplifier consists of three aluminum castings and the same general tendency in construction has been followed out in it as has been pointed out in the description of the tuner proper. The castings are polished, but no plating is required.

■

Preparing for Erasing

By C. Falik

Ironrite Ironer Company

PENCIL lines are difficult to erase from vellum. This is particularly true when the drawing is more than a month old, and the difficulty increases with the age of the drawing. On a tracing a year or two old it is

impossible to prevent the erased lines from showing on the blueprint.

A simple and efficient method of aiding in the erasures, and one that improves the tracing in general, I have found, is to apply some magnesium carbonate before drawing, as is done when preparing tracing cloth before inking. After such an application an erasure can be made with ease regardless of the age of the vellum tracing or the grade of pencil used.

■

Engineering Change Record

By L. Coon
Kellogg Manufacturing Company

MANY charts have been developed to keep the machine shop, tool, and timekeeping records in order, and here is a suggestion for the drafting room. Although the engineering department is on a "non-productive" basis, many an error in changes has caused confusion, sometimes costing real dollars and cents, by the neglect of thorough investigation at the time the change is made.

The chart is in the nature of a change card, in two parts or on each

ENGINEERING CHANGE RECORD

CHANGE NUMBER _____ DRAWING NUMBER _____

NAME OF PART-_____ DATE_____

USED ON _____

PROPOSED CHANGE _____

REASON FOR CHANGE _____

CHANGE TO TAKE EFFECT_____ RECOMMENDED BY _____

CHIEF ENG._____ GEN.MGR._____ PURCHASE _____

PROD. MGR._____ SALES MGR. _____ CHIEF INSP._____

SERVICE MGR. _____ TOOL DES. _____ MACH. SUP. ___

- - - - - - - - - Tear On This Line - - - - - - - -

CHECK BY DATING ALL CHANGES.

CHANGE NUMBER	DRAWING NUMBER
DETAIL.	*B.P. : Blue Print.
SUB.ASSEMBLY.	PART SUPERSEDES.
UNIT ASSEMBLY	SUPERSEDED BY PART.
INDEX CARD	
MATERIAL SPC.	CHANGE OF MATERIAL.
TOOL EQUIPMENT.	REWORK.
PATTERN.	PARTS IN MACHINE SHOP.
* B.P. MACH.SHOP.	PARTS IN STOCK.
B.P. INSPECTION.	PARTS IN PROCESS.
B.P. ENGINEERING.	
B.P. PURCHASE DEPT.	SCRAP
B.P. EXPERIMENTAL.	PARTS IN MACHINE SHOP.
OPERATING CARDS.	PARTS IN STOCK.
PLANNING CHART.	PARTS IN PROCESS.
	CASTINGS .
DRAFTSMAN ----------	PATTERN.

side of the same card. The upper part is circulated among the department executives and passed along in order for the signature of approval. The lower part of the card is retained by the engineering department for checking to keep the records up to date.

Material Standardization

By J. K. Olsen
Chief Draftsman, Stewart-Warner Corporation

IN many manufacturing plants there are found parts made from the same thickness, or within a few thousandths of an inch, of the same thickness of material, but some of these parts will be made of brass and others of steel. In cases of this kind it is excellent practice to standardize on one material in as many parts as may be found practical. Too many different opinions exist among designers in selecting various kinds of raw material for parts that are similar in design and function.

If standardization of kinds of material is accomplished, the next step is to concentrate on thickness of stock. There is no good reason why various stocks should be kept and used where there is a variation of only a few thousandths of an inch, but this is often the case. In designing a new product there should be a definite understanding that material used for other products should be specified in as many cases as may be found practical.

One item concerning the production of stamped parts that is seldom given due consideration is the width of strip material carried in stock. Often a slight rearrangement of material layouts will permit the use of a standardized strip size without increasing the weight per piece. In addition to the saving in cost, the standardized strip widths will provide a very flexible raw material inventory. Designing for forming or embossing will often permit the use of thinner stock than is at first considered necessary.

■

Licensed Engineering

By C. A. Koerner
Electrical Engineer, Delta-Star Electric Company

IT IS high time that we who take pride in our profession lend our whole-hearted support to the allied action of the founder engineering societies in bringing about the passage of a uniform registration law for engineers. Such a law, intelligently written and rigidly enforced, will accomplish a selection and designation of worthy men as accredited professional engineers, and vastly improve the status of the individual engineer.

Certain qualifications are common to all branches of engineering, mechanical, electrical, or otherwise. These are character, natural ability, and a thorough understanding of the basic sciences, mathematics and physics. Integrity comes as a blend of ability, both natural and acquired, with experience and sound common sense. In addition, each branch of engineering has its characteristics prerequisites, on which the applicant must be examined in detail.

Examinations should consist of problems to be answered orally or in writing, and also should include the inspection and analysis of the applicant's previous record and a study of his character. A committee of outstanding engineers should conduct these examinations and be empowered to reject any applicant for failure to measure up to specifications. The conferred title should be protected against misapplication or abuse at the hands of unqualified and unscrupulous individuals who would masquerade as engineers and cast a shadow over the profession as a whole.

■

Expensive Cheapness

By J. A. Covington

RECENTLY attention was called to an attractive display of pots and pans for domestic kitchens. They were made of a "stainless" steel, and were evidently a quality product. This was further borne out by the high prices on the tags. The durable construction and high grade of the material used very likely warranted the prices asked.

But alas! The designers had made one grievous error. Probably influenced by their enthusiasm over the new metal and desirous of keeping down the already high cost, the lifters for the lids were made of the same alloy steel. These lifters fairly yelled "cheap!", being nothing more than a narrow loop of the metal fastened to the lid by one rivet.

Across the aisle was another display of similar wares, but made of aluminum. The lids had neatly molded knobs of Bakelite or similar material. These knobs were securely fastened and were in keeping with the general design. They spelled sturdiness, grace and beauty, and showed that the manufacturer had provided protection against burning the fingers. There was nothing skimpy looking about this aluminum ware.

Regardless of the high quality of a material, its use in places where its properties do not meet the requirements of the user rarely is justified, even if it results in a small saving in cost. There is no excuse for cutting down the salability of an otherwise high-grade article by attaching to it an apparently makeshift device.

■

Speeding Up Drafting Work

By George H. Gunn

Engineering Dept., Naval Aircraft Factory

IN SECURING maximum speed-up, the following method is used in our plant to advantage. The drawings as originally drawn are made on pencil tracing cloth, which is a very satisfactory modern product, and they can then be blueprinted directly.

Then, if any particular part drawings are desired for standardization, or any parts of a drawing (say dimension figures) are particularly to be emphasized, or even if ink tracings are desirable for the whole job, it is a simple matter to ink directly over the pencil, if and when such tracings are needed. Pencil tracing cloth will take the ink satisfactorily.

The advantages are obvious; the information by way of blueprints, is gotten into the shop very much in advance; the draftsmen ink only parts actually needed to be inked, and it is done without pressure when detail draftsmen are available.

■

Comments on Gear Tooth Design

SEVERAL letters have been received commenting on the article on gear tooth design by Frank A. Mickle, which appeared in the July number. One prominent specialist on gear design pointed out that angle F, equation 3 on page 315, can be derived directly, as $F=tan\ J—J$. This is evident from a study of Fig. 2, *ih* being equal to *ig*, and all angles being expressed in radians.

Another point that has raised a question is the fact that the author resorted to an unexplained graphical solution in presenting his examples, as set forth in the first paragraph of the second column on page 316. In the graphical method used, the load applied to the top of the tooth is drawn to scale, in a direction normal to the tooth profile. The force is then split-up into two components, one radial and the other perpendicular to the radial center line of the tooth. The first causes compression, the second, a bending moment. The gear tooth acts as a cantilever beam, and its weakest section will be where the parabola, outlining the cantilever beam of uniform strength, is tangent to the tooth profile. The apex of the parabola is at the point where the line of action of the applied load intersects the radial center line of the tooth. The section modulus of the cantilever beam is calculated for cross-section where the parabola is tangent to the tooth profile. The length of the moment arm will be the distance from this section to the apex of the parabola. The bending moment stresses can then be calculated. The compressive stresses will be the radial load divided by the area of the tooth at the critical section, and the shearing stress will be the perpendicular component divided by the same area. The combined stress can then be calculated.

The author's object in the presentation of his paper was to prove the constancy of the angle he calls A, and to show the discrepancy when the direct compression and shearing stresses are ignored.

Rear-End Engines

By Chester H. Franklin

PLACING the engine in the rear of the automobile instead of in front, has still another advantage in addition to those pointed out in the editorial on page 383, Vol. 1. Such a location makes it possible to streamline the body and greatly reduce the wind resistance that is such a factor at the higher driving speeds of today. Those who have not realized the importance of this need only consult the designers of airplanes. The late Glenn H. Curtiss made some interesting experiments along this line that showed a great increase in speed with the same power.

If we already travel as fast as we should, as many contend, the streamlining of the body will enable us to maintain the present rate with a smaller engine and less gas consumption. Cooling problems may be increased by putting the engine at the rear, and there may be objections both to the changed appearance and to the removal of the engine as a buffer in case of collision. But we are likely to see such cars within a few years, just the same.

Improved Metals Affect All Products

CONTINUED FROM PAGE 423

is the principal advantage of the compositions for roofing and paneling. In flooring the desirable qualities are resistance to wear, ease of cleaning, and ability to absorb sound.

Copper tubing is being used by a number of operators to replace iron piping, because of flexibility and resistance to vibration and strains.

To obtain the same strength with much lighter members several manufacturers and operators have adopted aluminum in their equipment. The strong aluminum alloys were not introduced on a large scale until 1923, but up to the end of 1929 a total of 1,652 cars using this metal were built or ordered. Weight saving per car ranged from 1,330 lb., on those using aluminum for exterior sheathing only, to 13,500 lb., on a car using the metal very extensively.

In the actual car framing and body construction aluminum alloys have been used for many of the main members, side and end plates, handbrake levers, conduits, carlins, steps, bolsters, and other parts. They also have been employed in trucks for many of the heavy members.

Recent experiments have shown that aluminum alloys are satisfactory also for the motor frames of single phase motors, in which the motor shell is not a part of the magnetic circuit. In one motor the frame weight was reduced from 1,295 lb. to 533 lb. In motors where the steel shell is in the magnetic circuit, aluminum has been used for end housings, axle caps, and gear cases. Controller box frames also have been made of aluminum. Smaller but appreciable savings also have been obtained by making numerous accessory parts of aluminum.

Higher cost has been the greatest deterrent to the more general adoption of aluminum alloys for car construction. However, the smaller weights of material required, the energy savings possible, the lower first cost of motors and other parts and the lower maintenance cost of cars and tracks, largely offset the extra original cost. Use of this metal, as well as higher strength alloy steels, will continue to gain in favor in the continuing drive to improve the electric railway car.

PRODUCT ENGINEERING

Editor: KENNETH H. CONDIT

September, 1930

. . . A manufacturing company is only as good as its product, and unless that product be constantly improved it will not constantly draw the public to its buying. That is elementary, but often this fundamental seems to be neglected. . . —HENRY FORD.

This Depression Business

BACK in 1920, when business was in a deep depression, a metallurgist of a large company asked for funds to prosecute experiments with the metal tantalum, which up to that time had been used only for lamp filiments. It was a challenge to the far-sightedness of the management, but he got the money and the experimental facilities. As a direct result, the peculiar properties of the metal that make it so uniquely adapted as an electric rectifier and as a gaseous absorber were made available commercially because the metallurgist developed a process of producing and working the metal economically. The radio battery charger was thus put out in 1923, and then followed the high-vacuum tube that meant wonders to the radio industry. Other new markets were opened. The 1920-1923 depression was the time of opportunity for that particular company!

This fall there is to be announced in a nation-wide campaign a new household electric device that is somewhat "revolutionary" in its application. It is the direct outcome of an investigation by a chain store and one manufacturer of the possibilities of doing something that was declared "impossible." Instead of the original idea a new product unfolded itself, and the company expects to do a million-dollar business this coming year.

Two examples should be sufficient. Are you sitting by waiting for business to come back, or are you putting brains and thought into product development that will mean better business next year?

Must We Import Designers?

SOME months ago a large mid-western manufacturer appealed to the United States Department of Labor to be permitted to import foreign designers, claiming that it was impossible to procure a sufficient number of properly qualified American engineers. It has frequently been stated that European countries are better supplied with high-grade designers than is the United States. That is probably true. The German "diplom-ingenieur" is not required to serve consecutively as tracer, detailer, and layout man, after the completion of his university course, though he must undergo a comprehensive shop training before he is given his degree. This points out some of the weakness in the American system of developing men for positions as designers.

Drafting is drawing. To read type, one need not be an expert typist or printer. To read design drawings, one need not be a practiced draftsman. The correctness of design calculations and written specifications are not dependent on artistic ability. Yet too many of our manufacturers still insist that the technical graduate aspiring for a position as design engineer must first serve a long and uninteresting time as a draftsman. They do not recognize the fact that the rapid advance in the science of engineering has relegated drafting to the mere manual labor of pictorial presentation. It is for this reason that many technical graduates steer clear of the field of designing. Sales and production offer the opportunity of a more immediate and remunerative application of their college training.

At a recent meeting of professors of engineering it was disclosed that engineering schools as a whole are paying less attention to turning out practiced draftsmen and more attention to drilling students in the fundamentals of applied mechanics and basic engineering subjects. Will industry as a whole similarly recognize that skilled drafting should not be made a prerequisite to designing? A few of the most progressive companies have done so. But as long as the technical college graduates find so many of the roads leading to design engineering cluttered with useless requirements, they will seek other avenues. Instead of looking longingly towards Europe, let the American manufacturers create a domestic supply of design engineers. Much excellent raw material is available.

Down to Fundamentals

IN SEVERAL recent cases where lack of success was had in changing from one material to another on important machine parts the trouble could be traced back to the fact that the same patterns were being used for the new metal. It is easy enough to say that this is a shop or foundry matter, but when a designer decides to improve his product by trying another metal in the parts it would seem that the matter is of enough importance for him to get down to fundamentals and ascertain the effect on the shop and foundry.

It has been established definitely that patterns employed for brass or for malleable iron are not suitable for castings of aluminum, for example. For some machines, such as certain textile equipment, where strength or wear are not important in the part, it has been customary to run off lots of brass, bronze, or iron indiscriminately, depending upon the prices in the metal markets and the availability of the foundry at the moment. But this procedure is not possible for machine parts where the physical characteristics are important. Brass, bronze, aluminum, and iron run differently and act differently in the mold, and if the designer wants a fair test of a new metal for the parts he must see that new patterns are designed that take into consideration the properties of the metal. If this is done, there will be fewer replies that "We tried that metal, but it wouldn't give the service."

■

Silence!

NOISELESS operation is an asset in nearly all machines. Not infrequently it is the determining factor in making sales. Quite often noise can be reduced without any increase in cost, but in any way it is viewed the idea of killing off noise is likely to prove profitable.

Having produced engines that are almost noiseless in operation, automobile engineers are now seeking to eliminate even the noise made by air entering the carburetor, and that of air passing through the radiator and fan. Engineers in some few other fields have gone even farther, far enough to show that noise can be made negligible in most machines.

Whenever any new mechanical product is designed, therefore, it is important to ask the question, "Will it operate silently?" If the answer is "no," it will be better to consider the job unfinished until every reasonable effort has been made to eliminate noise.

Noise is always the result of vibration. Consequently, if vibration is eliminated or effectively damped out, silence is achieved.

▼

New Thoughts for Old

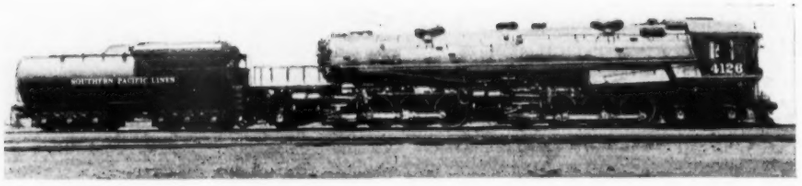
THERE is an opportunity for someone to make a name for himself by working out a metals code that will do for non-ferrous metals and miscellaneous alloys what the S.A.E. numbers have done for steel. In the designation of alloys it would seem that confusion reigns supreme, and the names given to some important alloys do not appear to mean any more than the catch-penny names given to tooth pastes or breakfast foods.

Even when the composition is designated, as in a 60-40 brass, there is confusion because some makers vary this composition widely without changing the name. An 18-8 "stainless" steel may mean 18 per cent chromium and 8 of nickel, or it may mean 18 chromium and 8 manganese. "German-silver," "Nickel-silver," and "Nickel-bronze" are used to indicate the same alloy, but the names are inaccurate because the metal is a nickel-bearing brass and is neither a silver nor a bronze. Furthermore, the names give no indication of the composition.

Trade names are even more confusing. One large company has gone a step forward by numbering and symbolizing its aluminum alloys. Government departments have also for a long time been using numbers and symbols for alloys. But there is increasing need now for some universal method of symbolizing that will be generally recognized by producers and consumers alike. Why continue to carry on with erroneous names, like aluminum-bronze, nickel-silver, or manganese-bronze? Why not adopt a name for each basic alloy classification and add numbers or symbols to give the user some intelligent idea of the characteristics of the alloy?

WHAT'S GOING ON—

The Month In Product Design



DANGER is always present in the use of photographers' flashlight powder. Photographers attempting to take pictures of machinery indoors are often justly prohibited from using flashlight powders because of fire hazards. A leading electric company has come to the rescue, however. The flash material, chemically treated aluminum foil, is contained in a bulb similar to an ordinary electric lamp, but filled with oxygen. When current is passed through the bulb, the foil ignites, causing a brilliant flash, but no explosion, smoke, or exposed flame, hence no fire hazard. The bulb may be set off with an ordinary flashlight battery. Products of combustion are sufficient to keep the bulb from collapsing after the flash, and several bulbs may be set off in parallel to increase the brilliancy of light.

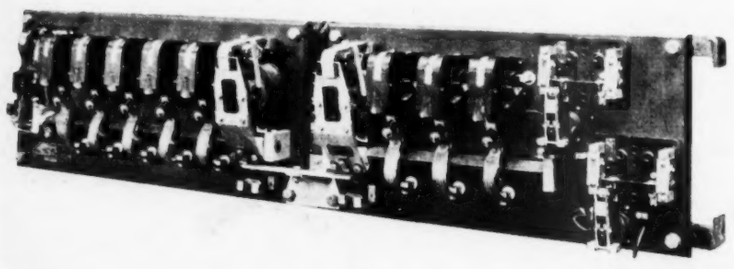
MOTOR PANELS for all kinds of machinery are in common use. The one shown in the accompanying illustration is unique in that the panel is split. This particular panel, though made expressly small so that it could be crowded into a machine, had nevertheless to be split so that it could be disassembled for shipment. The panel is of the two-speed type and consists of a three-pole and a five-pole, 150-amp., contactor, two double-pole temperature overload relays electrically reset, and a time relay to provide for starting at low speed. The five-pole contactor and the time-delay relay are shown on the right-hand panel, and the three-pole contactor and the electrically-reset temperature overload relay on the left-hand one. A mechanical interlock is used to span the 2-in. clearance between panels. This panel, manufactured by the General Electric Company, is used to control a 40-hp., 220-volt, 3-phase, 60-cycle, 900/450-r.p.m., high-resistance, squirrel-cage motor driving a J. H. Day dough-mixing machine.

A PORTABLE POWER PLANT, weighing 120 lb. and capable of delivering 1,000 watts, has been developed by Westinghouse. The plant is provided with Duralumin skids and is powered by a gasoline engine developing 2 hp. at 4,000 r.p.m. All moving parts but one are enclosed in a sealed bath of oil. Engine speed is controlled by an automatic mechanical governor and accurate speed adjustment is provided between 1,800 and 4,000 r.p.m. The gasoline tank has a capacity of 2½ qt., sufficient to operate the machine for three hours under full load.

THE accompanying picture of the Southern Pacific 4-8-8-2 locomotive illustrates that the best engineering design may require that conventional arrangements be discarded in order to meet unconventional conditions. In this instance the locomotive is used for hauling trains through the Rocky Mountain snow sheds. The cab is placed at the extreme front end of the locomotive in order to give the engineer an unobstructed view of the track. Oil, carried in the tender, is used for fuel. The fireman is stationed in the cab. This locomotive was built by the Baldwin Locomotive Works and is equipped with the latest fuel saving devices, including a Worthington open-type feedwater heater having a capacity of 12,000 gal. per hr. The locomotive has 24x32 in. cylinders, operates at a steam pressure of 250 lb. per sq.in., has 63½-in. diameter driving wheels, and is capable of exerting a tractive effort of 119,980 pounds.

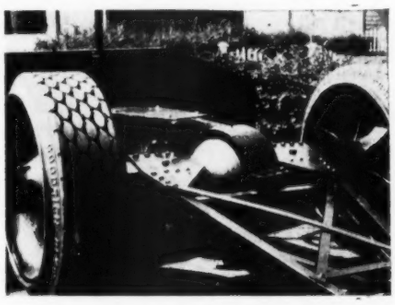
MINE CAGES made of Duralumin have been built recently in Germany. The saving in weight permits the operator to sink the shaft to a greater depth or increase the useful load carried by the cage without putting an added load on the engine. The Duralumin does not corrode when connected with iron, even in damp places, according to *Engineering & Mining Journal*.

REFRIGERATED display cases present difficult engineering problems, as set forth editorially in the August number of *Product Engineering*. The Weber Showcase & Fixture Company, Seattle, Wash., has recently placed on the market a refrigerated display case having five layers of glass panels with air spaces between them, the panels being set in rubber to prevent air leakage, thus preventing condensation on the glass surfaces. All refrigerated surfaces are flat so that frosting may be scraped off to eliminate the necessity of defrosting, according to *Food Industries*.



Front of motor panel for a Day dough-mixing machine

A RECLINING SEAT railway car, with the added features of a lunch counter, women's and men's smoking rooms, and other innovations, has been built by the Baltimore & Ohio Railroad at its Mount Clare Shops. The floor within and around the lunch counter is covered with inlaid rubber, while the aisles are carpeted. Interior decorations are finished in "living-room" style. In addition to dimmable ceiling lights, small individual night lights at each seat can be used at will by occupants. Seat arm rests are of sponge rubber composition, and the middle arm rests are collapsible and disappearing. Foot rests are also provided. Thermostatic control is provided on each side of the car, in addition to ceiling and window ventilators. Shock-absorbing rubber insulation is also used in construction.



A ball and socket supplants the usual swivel on this trailer made by the Omaha (Neb.) Steel Company. Timken bearings support the wheels

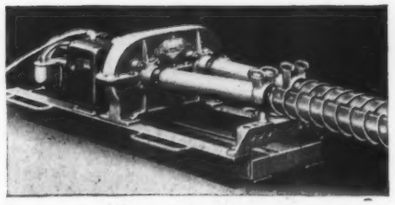
A CIRCULAR LOOM with rotating parts would permit higher speeds and eliminate much of the shock, vibration, and wear present in the ordinary loom with its reciprocating motions. Robert G. Clark of Brooklyn, N. Y., recently demonstrated a circular loom on which he has just received patents. The loom wove a tubing 3 or 4 in. wide at the rate of 250 picks a minute, even though crudely built, according to *Textile World*. By bettering the construction, higher speeds are possible, and the woven tube may be split by a cutting device on the loom. For many purposes, splitting of the tube is unnecessary.

AN OIL BURNER CONTROL that provides automatic lighting and re-lighting of the fire and insures safety against failure as a result of interruption of electrical current or of fuel supply has been put on the market under the trade name of the "Electrical Brain" by the Phoenix-Detroit Burner Corporation, Detroit. The "brain" is a small electrical unit contained in a steel box adjacent to the furnace. A single switch turned to "on" of "off" positions operates it. When the switch is turned on, the electrical current is shunted into the lighting element for a period of 90 seconds. At the end of this period the "brain" opens the oil valve and starts the motor, the oil stream is directed over the lighting element and flame is carried out into the combustion chamber. With combustion established, the current to the lighting element is then turned off. This routine will repeat itself indefinitely.

A Glance Over the Pages—

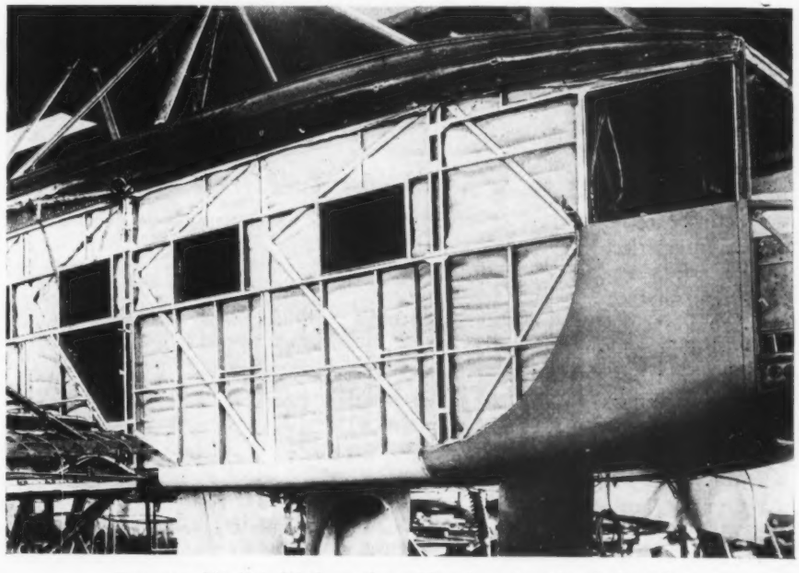
1. *Why cannot equations used for crossed belts be used for open ones? p. 424*
2. *When is Stellite used for valves? p. 403*
3. *Why is machinery gray? p. 429*
4. *Why did certain automobile designers go back to malleable iron? p. 410*
5. *How much drawing work should the development or "project" engineer do? p. 407*
6. *What are the reasons for incorporating standard motors in the product? p. 442, 445*
7. *How do welded parts compare in cost with cast ones? p. 405*
8. *How are "hard motions" shown in a chart? p. 409*
9. *Why use Duralumin for mine cages? p. 436*

RADIO RECORDING DEVICES, so simple that a child can operate them by simply throwing a switch, are being incorporated in the new RCA Radiola Superheterodyne Model 86, according to *Radio Retailing*. A small microphone picks up the program and transcribes it on the disk, from which an immediate play-back can be had. Records are cellulose, 6 in. in diameter, and will play 110 seconds at the normal rate. A special chromium-plated needle does the recording, and the device is hooked up to the amplification system of the set. Records are pregrooved and the device may be used also to record individual records of home events by members of the family.

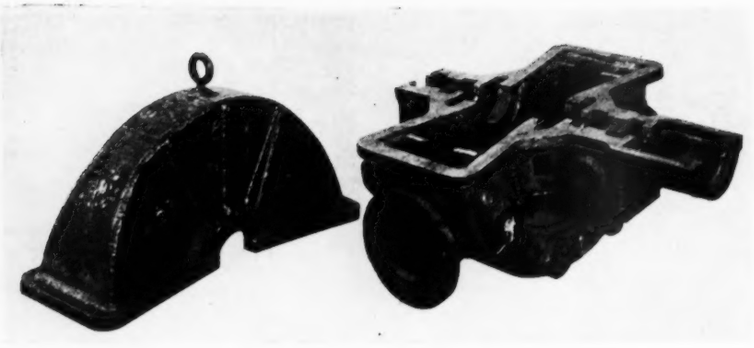


Two external spiral tubes turned toward each other by a power head form the Clark Twinveyor for conveying bags, bundles, and bales

NOISE ABATEMENT in airplane cabins has been experimented on for over two years by the Aeronautics Branch of the U. S. Department of Commerce, according to the "Air Commerce Bulletin" of that department. Recently a "Curtiss Condor," having a main cabin about 28 by $6\frac{1}{2}$ ft. by $6\frac{1}{2}$ ft. in height, was experimented upon. The cabin had its entire exterior top covered with 0.032-in. aluminum-coated Duralumin, the sides covered with fabric and the underside partially covered with 0.04-in. aluminum-coated Duralumin and partially with fabric. Between the exterior and interior finish was fitted a $1\frac{1}{2}$-in. layer of dry-zero blanket fastened between the structural members with small furring strips. No dry-zero blanket was used under the floor. Triplex glass, $\frac{3}{16}$ in. thick, was used in the 14 outside windows. Largely because of this special type of wall construc-



Dry-zero blanket fitted on the cabin of a plane to abate noise



Welding Enters the Intricate

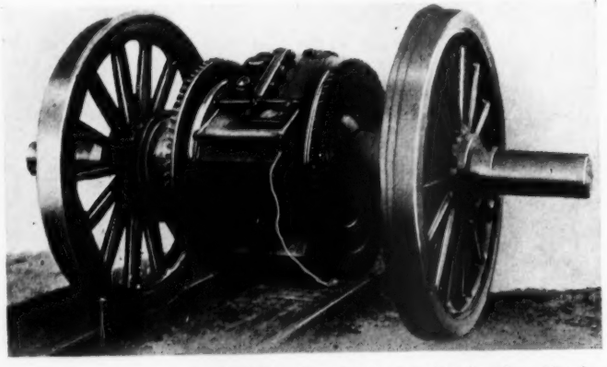
A steam turbine weighing 840 lb. and tested at a pressure of 2,000 lb., manufactured completely from steel plates by the Youngstown Welding & Engineering Company with Lincoln "Stable-Arc" equipment. The body is 1¼-in. plates, the rotor ways ⅝-in. plate

tion using the zero-dry blanket, the noises in the cabin were reduced to a level of those in a railroad coach in motion. Speaking could be carried on in ordinary conversational tones with good intelligibility up to 7 feet.

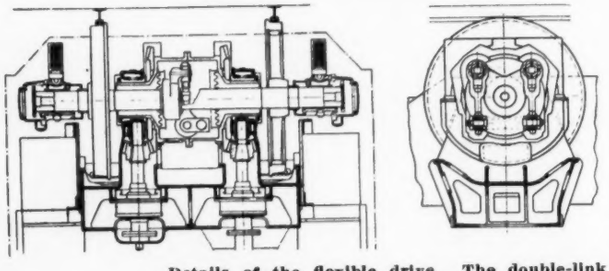
VERTICAL MOTORS feature the locomotives used by the Austrian Federal Railways built for high-speed passenger service, according to *Electric Railway Journal*. Twin motors drive individual axles through bevel gears. Each axle carries a quill flexibly mounted through links. At each end is a bevel gear held in a fixed position with respect to the motor and the locomotive frame. The driving mechanism is housed conveniently in a drum-shaped casing. The flexible links between quill and axle are carried inside the drum. Two guiding rods are linked on one side to arms on a short shaft carried on bearings within the drum, the other ends of the rod being connected to two crank pins mounted on arms projecting from the driving axle. Ball joints at either end of the rod provide full flexibility in every direction between the driving wheels and the spring-supported unit of body, motors, and quills. Bevel gears are of the helical type, and there is a twin-step bearing on each motor shaft to absorb vertical thrust. Twin motors were adopted because of the need for increased output.

A.S.A. Adopts Standards

A new American Standard for symbols for photometry and illumination has been adopted by the American Standards Association. The standard is a modification of the American Standard for Illuminating Engineering Nomenclature and Photometric Standards adopted in 1925. Other recently adopted standards include that on annular ball bearings of the single-row type (light, medium, and heavy series), milling cutters, slotted head proportions, and cut and ground thread taps. The proposed standard on ball and roller bearings of the wide type has been adopted as American recommended practice by the association.



Assembly of a driving axle showing the inclosed flexible links and the twin bevel gears



Details of the flexible drive. The double-link connection permits of considerable motion between wheels and body of the locomotive

Research Laboratories To Be Built

A number of companies have recently announced construction of research laboratories. Important among these are that of the American Telephone & Telegraph Company on a tract of 200 acres near Elizabeth, N. J., and that of the Hercules Powder Company, Wilmington, Del., which recently laid the cornerstone of the new building of the new experimental and research laboratories. The A. T. & T. Laboratory will be built to relieve the pressure for space now felt in the Bell Telephone Laboratories at 463 West St., New York. The Hercules Laboratories, costing $500,000, are being built at Hercules, Del., three miles west of Wilmington, and will house the laboratories brought from Kenvil, N. J.

Engineers Requested For Civil Service

The United States Civil Service Commission recently announced open competitive examinations for a number of engineering positions, including those of senior mechanical engineer and mechanical engineer. Salary offered for the first mentioned is $4,600 to $5,200 a year, and for the second from $3,800 to $4,400. Applications must be on file with the United States Civil Service Commission at Washington not later than Sept. 10. Duties include having charge of and directing the work of other engineers in the design of important structural and mechanical features in connection with the design and specifications for Boulder Dam, including design of machinery and appliances.

A.S.M.E. Gage Committee Begins Organization

Upon request of the American Standards Association, the A.S.M.E. recently accepted sole sponsorship for the development of an American Standard for Pressure and Vacuum Gages. In order that this Sectional

Committee may meet early in the fall, invitations have been addressed to 55 societies and associations requesting them to appoint representatives on this Committee. The tentative scope outlined for this project is: "Nomenclature and definitions of pressure and vacuum gages; capacity ratings; case sizes and mounting holes with a view to obtaining maximum interchangeability; dials and graduations and designation of units; indicator hand and bushing; zero stop pins, bezel rings and their attachment to the gage; connections to the gage; method of expressing allowable errors or accuracy of the gage; and requirements for accuracy.

National Metal Congress Schedules 35 Technical Sessions

THE 1930 National Metal Congress, convening at the Hotel Stevens, Chicago, the week of Sept. 22, will have 35 technical sessions on its program. The American Society for Steel Treating, the American Welding Society, and the American Society of Mechanical Engineers are each devoting eight sessions to the presentation of technical papers, while the American Institute of Mining and Metallurgical Engineers will have seven such sessions.

Meetings of the American Welding Society will be held in the Congress Hotel, but the remainder of the sessions will be held in the Hotel Stevens. Among the A.S.S.T. papers are: Corrosion and Heat-Resistant Nickel-Copper-Chromium Cast Iron; Physical Properties of Fine Bolts; Stresses and Cracks in Hardened and Ground Steel; Cemented Tungsten Carbide; Effects of Prequenched Treatments on the Hardness, Body and Structure of Hardened Tool Steel; Scaling of Steel at Forging Temperatures; Oxygen in Steel; Critical Ranges in Pure Iron-Carbon Alloys; Relationship Between Welded-On Overlays and Heat Treatment; Influence of Nickel on the Chromium-Iron-Carbon Constitutional Diagram; Study of a High-Chromium, Low-Carbon Steel; Corrosion Test for Research and Inspection of Alloys; Nature of the Nickel-Chromium Stainless Steels; Tensile Properties of Carbon Steel Castings; Microcharacter Hardness Tester; Relation of Structure to Surface Hardness of a Case-Hardened Steel; and Resistance of Steel to Abrasion by Sand.

The American Welding Society's schedule includes these papers: The Examination of Welds by the X-Ray Diffraction; Fatigue Investigations of Welded Joints; Stress Distribution in Welded Joints; Testing of Welds; Welded Steel Bar Joints; Cost of Using Welding; Strength of Welded Joints in Tubular Members for Aircraft; Tensile Tests for Welds; Bend Tests for Welds; Shear Tests for Welds; Impact and Fatigue Tests for Welds; Double Lengthening Railroad Rails; Magnetic Testing of Butt Welds; Welding of Stainless Steel; Arc Welding of Aluminum; and Oxy-Acetylene Welding of Corrosion-Resisting Steels.

Included in the A.S.M.E. program are: Phenol Resinoid Molding Technique; Flange Type Motor Mounting; The Mechanical Design of Electric Motors, as Regards Standardization and Interchangeability; Report of Anti-Friction Heavy-Duty Bearing Committee; General Design and Construction of Hot Saws for Cutting Heavy Structural Steel Sections.

The Business Outlook

Business apparently hit a second bottom at the beginning of August, just a year after it went over the top in 1929. Since then, little change but indications that a slow up-pull has set in. Our index, with its final figures steady at 66.5% of normal for two weeks, rose a trifle to this week. Last year it came down quite a peg to 111.5%, beginning its swift slide. Industrial activity is still stagnant, but has reached resistance levels, despite the astonishing slackness of seasonal forward buying in wholesale lines, which is leaving retail shelves bare. General trade, discounting drought doubts, has freshened since the first of the month. Commodity prices are decidedly firmer. Bears have made little headway in any markets. Whether the business recovery from now on is to be slow or fast, only seasonal or permanent, is now chiefly a question of revival of individual initiative and aggressiveness which has been weakened in the past few months by repeated disappointment in miracles and by defeatist doctrines. Business may be slack, but business men are slacker.

—*The Business Week*, Aug. 27.

News of the Metal Markets

DULLNESS characterized metal markets during the past month, according to *Metal & Mineral Markets*. Little copper could be sold, zinc was not in demand, and tin was quiet, although silver recently assumed a stronger position at 35.8c. a troy ounce.

LEAD output decreased in July, but stocks are still increasing through lack of a market. Sales are a little better at 5.35c., St. Louis. Foreign takings have been particularly good, but domestic buyers show little interest in a price lowest since 1915.

COPPER is hovering between 10¾ and 11c., lowest since 1914, with neither producers nor consumers interested. Requirements for some months ahead have been booked, and no further drop in price is expected. World daily output is decreasing but slightly. A sharp decrease in the copper used in domestic water heaters has been noted.

ZINC producers, anxious to sell prompt metal, are asking 4.3c., and new concentrators being opened are recovering only copper from ores, zinc's low price forbidding its extraction. Zinc prices in 1921, their most recent low, were 4.8c., considerably above the present price.

TIN prices, fluctuating between 29.9 and 30.1c., reflect market quietness. Although visible supplies have declined, little change is expected until producers' efforts at restriction meet with more success.

SELENIUM, comparatively rare, could be produced at a rate of from 400,000 to 450,000 lb. annually, according to the U. S. Bureau of Mines, if a market were developed. New uses are occurring in medicinal, chemical, and rubber industries.

A. O. Smith's 7-story research and engineering building now being built in Milwaukee, where 1,000 research workers will be employed

IN THE SPOTLIGHT—

LEON V. QUIGLEY, Bakelite Company, New York, will present a paper entitled, "Phenol Resinoid Molding Technique" at one of the A.S.M.E. sessions during the National Metal Congress.

WALTER G. BARCUS, previously a student aviator at the United States Navy Naval Air Station, Pensacola, Fla., has been appointed a research engineer with the National Advisory Committee for Aeronautics at Langley Field, Hampton, Va.

WELLWOOD BEALL has resigned his position as aeronautic engineer with the Walter M. Murphy Company, Pasadena, Calif., to become instructor in design at the Boeing School of Aeronautics, Oakland Municipal Airport, Oakland, Calif.

ROLAND G. BERND, designing engineer for aircraft at the Szekely Aircraft & Engine Company, Holland, Mich., has resigned his position to go with the Leonard Motorless Aircraft Co., Inc., Grand Rapids.

FRANK G. BORN, formerly chief engineer in charge of automotive equipment for the Wahl Company, Chicago, has become a member of the engineering department of the Delco Products Corporation, Dayton, Ohio.

C. H. BRANDES, formerly chief mechanical engineer and general purchasing agent of the American Metal Company, Ltd., and subsequently vice-president of the Metallurgical & Chemical Corporation, and the International Process & Engineering Corporation, has joined the Western Precipitation Company, Los Angeles and New York.

VICTOR W. PETERSON has been elected president of the Shafer Bearing Corporation, Chicago. Mr. Peterson is also president of the Hannifin Manufacturing Company and the Sherman-Manson Manufacturing Company.

VANCE BREESE, lately president of the Breese Aircraft Corporation, Portland, Ore., is now assisting with designing, sales, and test work at the Detroit Aircraft Company, Detroit, Mich.

E. C. BULLARD, whose appointment as research and development engineer of the Bullard Company, Bridgeport, Conn., was announced four months ago, was appointed a vice-president at a recent meeting.

PETRUS A. CARLSON, formerly chief engineer of the Commercial Aircraft Company of America, Bridgeport, Conn., is now a designing engineer with the Sikorsky Aviation Corporation of Stratford, Conn.

EVERETT CHAPMAN has been appointed director of development and research of Lukenweld, Inc., a division of the Lukens Steel Company, Coatesville, Pa. Mr. Chapman will have general direction of laboratory and investigation work in connection with the redesigning of machinery parts for the welded steel type of construction.

CHARLES A. CHAYNE, formerly in charge of development and design for the Marmon Motor Car Company, Indianapolis, Ind., has become head of the Motor Division of the Buick Motor Company, Detroit.

JOHN CHUCAN has resigned as chief engineer with the Mercury Manufacturing Company, Chicago, and is now traveling in Europe.

ROBERT I. DICK, formerly engineer with the Buhl Company, Chicago, has become assistant chief engineer of the Wisconsin Motor Company, Milwaukee.

L. V. Quigley

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V. W. Peterson

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E. C. Bullard

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P. A. COLLINS, sales engineer for over a year at the Bendix Brake Company, South Bend, Ind., was appointed recently to the position of sales manager of the Muncie Products Division of the General Motors Corporation, Muncie, Ind.

GEORGE R. DAVENPORT has accepted a position on the engineering staff of the Hupp Motor Car Company, Detroit. He was formerly on the engineering staff of the Studebaker Corporation, and more recently with the Graham-Paige Motors Corporation.

A. V. DE FOREST, formerly research engineer for the American Chain Company, has been appointed consulting engineer. He will be associated also with the newly organized Welding Engineering & Research Company, New York City.

C. H. DENGLER, formerly chief engineer of the New Way Motor Company, Lansing, Mich., has become a designing engineer of the Westinghouse Electric & Manufacturing Company.

ERNEST DICKEY is now research engineer with the North East Appliance Corporation, Rochester, N. Y., Mr. Dickey was previously chief engineer for the Delco Light Company, Dayton, Ohio.

CHARLES L. DRAKE has accepted a position as sales engineer with the Fafnir Bearing Company, New Britain, Conn. Mr. Drake was formerly assistant manager in the automotive division of the Yale & Towne Manufacturing Company, Detroit.

G. O. GOLLER, formerly serving the General Motors G.m.b.H., at Berlin, Germany, as a body engineer, has joined the body engineering staff of the Adam Opel A. G., at Ruesselsheim on Main, Germany.

T. W. HALLERBERG, for the last two years chief engineer with Lubrication Devices, Inc., Battle Creek, Mich., has become executive engineer with the Pickwick Motor Coach Works, Inglewood, Calif.

KNUT HENRICHSEN, former assistant chief designer for the Curtiss Aeroplane & Motor Company, Garden City, N. Y., has become a project designer with the Curtiss Robertson Manufacturing Company, Robertson, Mo.

B. F. HIRSCHFELD, research engineer, Detroit Edison Company, has been selected to undertake an extensive investigation of the problem of car design under the auspices of the President's Conference Committee of the American Electric Railway Association.

GROSVENOR HOTCHKISS, who has been with the Western Union Telegraph Company, New York City, as engineer, recently joined the Teleregister Corporation, New York City.

DALE P. JACOBUS, formerly research engineer in the new development department of the Foster Vernay Corporation, Brooklyn, N. Y., has become a partner in the Jacobus Engineering Company, Cleveland.

M. C. RYPINSKI has been appointed manager of the Radio Department of the Westinghouse Electric & Manufacturing Company. He entered the electrical industry in 1897 as an engineer and joined the Westinghouse Company in 1904. Mr. Rypinski retired in 1928 but now has rejoined the Westinghouse Company.

SCOTT F. HUNT, formerly sales engineer for the Bendix Stromberg Carburetor Company, South Bend, Ind., has been made assistant chief engineer.

J. B. JACKSON has been named general manager of the Jaxon Steel Products Division, General Motors Corporation, Jackson, Mich. Until recently he was director of the general service staff and business director of the General Motors research laboratories at Detroit.

S. JOHNSON, JR., has been appointed chief engineer of the newly formed Bendix-Westinghouse Automotive Air Brake Company, Pittsburgh. Mr. Johnson was formerly identified with the Chicago office of the automotive brake division of the Westinghouse Air Brake Company.

FRANK E. ELDREDGE has been appointed assistant to the manager of the Radio Department of the Westinghouse Electric & Manufacturing Company. In this capacity, Mr. Eldredge will continue to supervise Westinghouse activities on radio with the U. S. Government and relations with associated radio interests.

F. K. KNOHL, formerly a truck designer for the Fargo Motors Division of the Chrysler Motor Company, Highland Park, Mich., has been appointed research engineer with the Illinois Tool Works, Chicago, Ill.

EDWARD T. BIRDSALL, previously connected with the Wright Aeronautical Corporation as engineer, has joined the engineering and research department of the Curtiss-Wright Corporation, New York City.

G. C. R. KUIPER, recently a chassis experimental engineer for the Stutz Motor Car Company, Indianapolis, has been made assistant to the chief engineer of the Midland Steel Products Company, Cleveland.

CARLTON J. LAUER has become chief engineer in the refrigeration division of Brooks Steam Motors, Inc., Buffalo. He was previously an engineer with Chrysler Motors, Inc., Detroit.

J. M. LESSELLS, DR. J. P. DEN HARTOG, DR. TIMOSHENKO, and R. E. PETERSON, all of the Westinghouse Research Laboratories, attended the third International Congress for Applied Mechanics held in Stockholm the week of Aug. 25.

DR. GEORGE K. BURGESS, director of the U. S. Bureau of Standards, was re-elected president of the National Conference of Weights and Measures at the annual meeting. Dr. Burgess has sponsored a number of research programs being carried on at the Bureau, including one on testing of screw threads and locking devices.

M. C. Rypinski

F. E. Eldredge

E. T. Birdsall

G. K. Burgess

LAWRENCE C. PORTER, formerly engineer in charge of special developments at the Edison Lamp Works of the General Electric Company, Harrison, N. J., has been named manager of the health and therapeutic lamp section of the company's engineering department.

EDWARD B. NEWILL, electrical and mechanical engineer, has been appointed vice-president of the Frigidaire Corporation, Dayton, Ohio, in charge of engineering.

A. G. PLIMMER, formerly machine designer with the National Carbon Company, Fremont, Ohio, has been placed in charge of the experimental department of Cincinnati Grinders Incorporated.

W. W. SLAGHT, until recently chassis experimental engineer with the Pierce-Arrow Motor Car Company, Buffalo, has become chief engineer of the Cleveland (Ohio) Steel Products Company.

A. R. SMITH has been appointed executive engineer of the turbine engineering department, General Electric Co., to succeed the late William J. Delles. Mr. Smith will retain his responsibility as engineer of the construction engineering department.

CLAUDE O. STREETER, who for the past 18 years has been associated with Graton & Knight Company and its subsidiaries as chief mechanical engineer, has resigned to accept a similar position with the Schwartz Belting Company, 76 Murray St., New York City.

CONRAD A. TEICHERT, formerly engine designer and mathematician for the International Harvester Company at the Fort Wayne, Ind., plant is now employed in the research division of the Bendix Brake Company of South Bend, Ind.

EDWARD N. TRUMP has resigned from the Solvay Process Company, with which he has been connected for 48 years in engineering, managerial, and executive capacities. Upon his return from the World Power Conference, Mr. Trump will open offices in Syracuse, N. Y., as a consulting mechanical and chemical engineer.

KENNETH W. WARREN, formerly chief design engineer with the Le Blond Aircraft Engine Corporation, Cincinnati, has accepted a position as research engineer with the Bendix Aviation Corporation, South Bend, Ind.

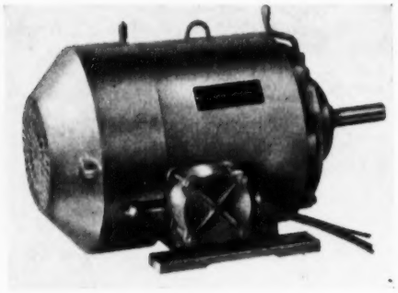
WILLIAM M. WHITE, manager and chief engineer of the Allis-Chalmers Manufacturing Company, Milwaukee, was honored by Tulane University recently when he received the first honorary degree of Doctor of Science ever conferred by that institution. Mr. White has become a recognized authority in hydraulic work and has to his credit the designing of some of the largest turbines in the world.

WAYNE H. WORTHINGTON recently became a research engineer with the John Deere Tractor Company, Waterloo, Iowa. He was previously chief engineer with the Gleaner Combine Harvester Corporation, Independence, Mo.

NEW MATERIALS AND PARTS AND ✦ ENGINEERING EQUIPMENT ✦

Allis Totally-Enclosed, Fan-Cooled Motor

A SEALED MOTOR easy to take apart has been produced by the Louis Allis Company, Milwaukee, Wis., known as the Type J, fan-cooled, ball-bearing motor. This is a modification of the Type R motor and utilizes similar methods of inclosing and ventilating. Additional refinements include



Cast-iron heads and "cartridge type" bearing chambers are used in the Allis totally-enclosed squirrel-cage motor

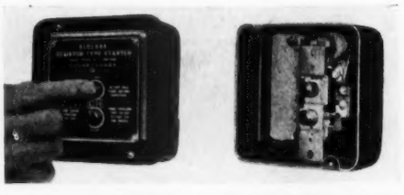
"cartridge type" bearing chambers, and simple devices for removing the fan, ventilating shell, and heads quickly. As a result, maintenance men can dismantle and reassemble Type J motors in less than five minutes under ordinary conditions.

Type J is a totally-enclosed motor sealed inside a sheet-steel ventilating shell. All enclosing parts are joined by long close fits, all metal-to-metal and at least $\frac{3}{8}$ in. wide. All bearing chambers are within the enclosure, thus utilizing the oil seals and fits of the cartridges around the shaft to exclude foreign matter. Cast iron heads are used with no holes passing from outside to inside. Cap screws holding the heads to the frame pass through holes in lugs projecting outside the head fit. The cast iron heads are exchangeable end for end. No pipe connections on air ducts are required. The back bearing may be inspection without disturbing the fan guard, fan, front head, or rotor. A socket wrench is claimed to be the only tool required and the time is said to be three minutes or less.

Cutler-Hammer Resistor Starter, Small Motor

FRACTIONAL horsepower dc. and single-phase a.c. motors can be controlled by means of a resistor-type starter announced by Cutler-Hammer, Inc., 80-12th St., Milwaukee, Wis. This starter is designed particularly for those applications where power company rulings require that the inrush current of small motors connected to lighting circuits be held within definite limits, and where the high inrush current incident to starting across-the-line is otherwise objectionable. In starting, a resistance is inserted in series with the motor, and as the motor accelerates and the inrush current decreases, the starter automatically short-circuits the resistor and connects the motor across the line. It is push-button operated and provides thermal overload protection to the motor.

The overload relay acts directly on the contact mechanism. Small



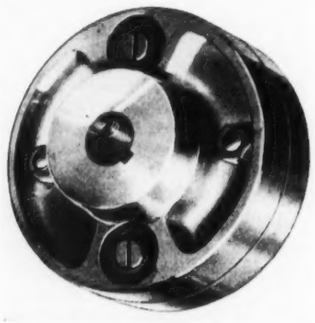
Designed for installations where small motor inrush current must be held within definite power-line limits

overloads and overloads of short duration do not trip the mechanism, and therefore the motor is disconnected only when it is in danger of being burned out.

Maximum ratings are $\frac{1}{4}$-hp., 115 volts d.c., and $\frac{3}{4}$-hp. 110 or 220 volts, a.c.

Ajax Type E Coupling

MODIFICATION of the standard Type A flexible coupling has resulted in the Type E recently placed on the market by the Ajax Flexible Coupling Company, Westfield, N. Y. It is a special coupling of limited size, and is designed for economical use on applications such as centrifugal pumps, small speed reducers, fans, and motor-generator sets. It is of the standard rubber-bushing type, and is made with aluminum-alloy flanges, hardened and ground alloy-



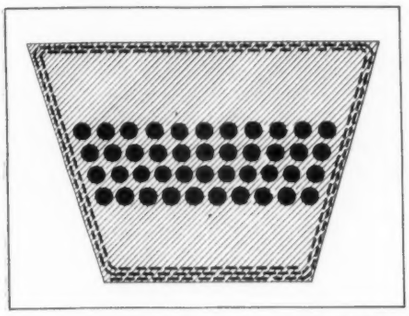
Aluminum-alloy flanges are employed for the Ajax Type E flexible coupling, which will transmit up to 7½ hp.

steel drive studs and specially compound rubber bushings cemented to hard bronze bearings by an improved process. The weight is only 2 lb. per coupling because of the aluminum flanges. The outside diameter is 4 in.; the over-all length $2\frac{1}{16}$ in., and the power transmitted, $7\frac{1}{2}$ hp. at 1,750 r.p.m. on steady loads. A $1\frac{1}{2}$-in. maximum bore or special keyways can be furnished.

The Type E flexible coupling is claimed to be noiseless in operation, free from vibration, easy to assemble, free from backlash, and provided with free end float. Its smooth aluminum construction adds to the appearance of the machine to which it is applied.

Worthington Multi-V-Drive

A "MULTI-V-DRIVE" developed in conjunction with the Goodyear Tire & Rubber Company, has been placed on the market by the Worthington Pump & Machinery Corporation, Harrison, N. J. This drive consists of a number of endless molded V-belts running in V-grooved sheaves. It combines a rubberized cord V-belt, impervious to dust and moisture, with



Cross-section of Worthington "Multi-V-Drive" Belt, showing how the cotton cords are arranged in parallel lines and concentrated about the neutral axis

an improved V-grooved sheave. The load-carrying members are high-grade cotton cords arranged in parallel lines and concentrated about the neutral axis. Among the claims made for this belt are: high power capacity, long flexing life, low stretch, accurate cross-section, and high-quality rubber.

Each sheave is grooved, machined, and finished so that the grooves present a smooth surface on which the belts run. The wedging action between the belts and the grooves results in a slipless, powerful grip. Transmission of about 99 per cent of the applied power is claimed at high speed ratios, over short centers, without idlers. It is claimed that should one of the strands of the "Multi-V-Drive" break the remaining belts will carry the load until replacement is made.

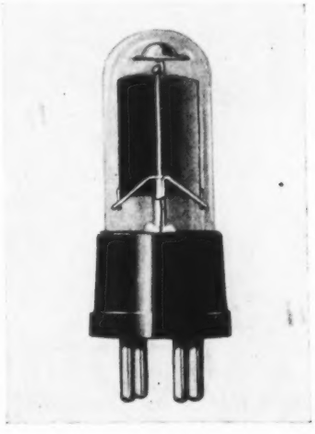
Other claims made for the belt are: quiet operation; neatness; small floor space; constant speed; elimination of idlers, lubrication, and belt dressings; higher speed ratios; and freedom from breakdowns.

Kalif Bushing Stock for Bearings

CENTRIFUGALLY cast copper-lead bushing stock for bearings has been placed on the market by Kalif Corporation, Emeryville, Calif. The bushing stock is applied in 252 regular sizes, all semi-finished, allowing $\frac{1}{16}$ in. on the inside and outside diameters for final finishing. Among the physical characteristics are the following: Thermal conductivity increased from three to six times over ordinary bearing materials, non-scoring and non-seizing, high frictional heat resistance, and easy machinability. The outside diameters of this bushing stock range from 1 to 6 in., and the inside diameters from $\frac{1}{2}$ to $5\frac{1}{2}$ in.

"Visitron" Photo-Electric Cells

FOUR "Visitron" photo-electric cells have been placed on the market by the G-M Laboratories, Inc., Grace & Ravenswood Aves., Chicago, Ill. These photo-electric cells are available in two types: Type A, filled with an inert gas at a low pressure, and Type AV, a vacuum type having less photo-electric current than the previous model. In the Type A cell the photo-electrons ionize the gas in their passage from the sensitive surface to the anode and the resulting ionization current is added to the electron current, giving a larger total



Inserted metal plate design in the "Visitron" cell is claimed to be an improvement

photo-electric current than in the second model.

The inserted metal plate construction is claimed to be an improvement over older types of such cells in which the sensitive surface was deposited on the inner wall of the glass envelope. Such construction insures uniform physical characteristics as well as mechanical and electrical sturdiness. Industrial applications of these photo-electric cells include talking motion picture apparatus, illumination control in factories and drafting rooms, transmission of signals by light, burglar and fire alarms, grading of materials according to color, detection of flaws in raw and unfinished products, accurate control of constant temperature baths, and optical counters and timing devices.

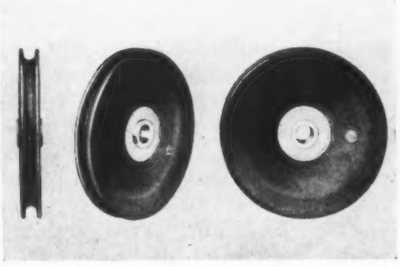
Brevolite Coating Lacquers

FLAT surfaces of metal, wood, and composition can be finished with the coating machine lacquers developed by the Brevolite Lacquer Company, North Chicago, Ill. Coating such surfaces in roller coating machines permits higher speeds of operation than the spraying process, and perfect flow and coverage are claimed. The drying time is a little slower than that of the corresponding spray lacquer, but not slow enough to cause trouble.

Coatings so applied are quite flexible, in that the metal or composition can be distorted considerably without breaking the finish. Various colors and black and white are available, and also a medium for applying bronze powder and various special finishes. The thickness of the material to be coated may vary from 30-gage metal to $\frac{1}{2}$-in. composition. Shallow embossings or small etchings may also be coated. It is claimed that a material saving is effected by the coating machine process over the spray process.

General Electric Molded Compound Pulleys

MARINE and railway signal work, materials handling, elevators, and aircraft controls are applications of the molded compound pulleys announced by the General Electric Company, Schenectady, N. Y. These



Molded Compound Pulleys are being produced by General Electric with outside diameters of 1¼ to 3¼ in.

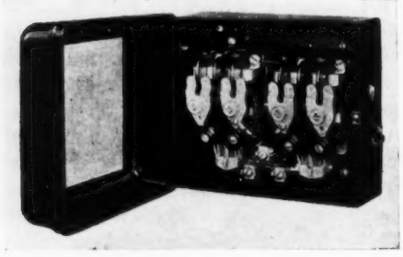
NEW MATERIALS AND PARTS

pulleys meet Army and Navy specifications 210-1, 2, 3, and 4, and the Department of Commerce has approved the last named application. They are made of "Textolite" molded around ball bearings, and are of the single-row, self-contained type with dust shields.

Four sizes are included in the line. The outside diameters are $1\frac{1}{4}$, 2, $2\frac{1}{2}$, and $3\frac{1}{2}$ in., and are supplied in various combination of diameters and bearings. The $1\frac{1}{4}$ in. pulleys have plain sleeve bearings for $\frac{3}{16}$-in. or $\frac{1}{4}$-in. pins, or ball bearings for $\frac{3}{16}$-in. pins only. The 2-in. size employs plain sleeve bearings for $\frac{1}{4}$ or $\frac{3}{8}$-in. pins, or ball bearings for $\frac{1}{4}$-in. pins. The $3\frac{1}{2}$-in. pulleys may be had with either plain sleeve bearings, or ball bearings for both $\frac{1}{4}$ or $\frac{3}{8}$-in. pins. All sizes, except the $3\frac{1}{2}$-in. ball bearing pulleys, have just been placed on the market.

Square D Reversing Contactor, Small Motor

A CLASS 8711 reversing contactor for small motors has been developed by the Square D Company, Industrial Controller Division, Milwaukee, Wis. This contactor is for use primarily in operating controls on small machine tools and is manufactured in two types, one for two-wire control only and the other for two- and three-wire control. The starter may be wired for controlling single-phase,



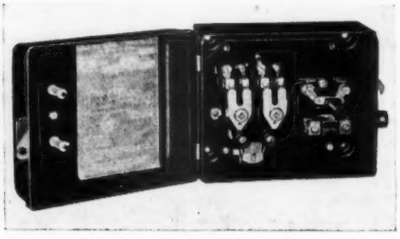
three- or four-wire reversible motors, or three-phase motors. It consists of two double-pole, double-break contactors mechanically interlocked and mounted side by side on a sheet steel panel in a sheet steel case. The contactor armatures are of the full-floating type and the wiring terminals are conveniently located at the top.

Starters for use with single- and three-phase motors are available in $1\frac{1}{2}$-hp., 110-volt, or 3-hp., 220-volt models. The inclosing case is $8\frac{1}{2}$ in. wide, $6\frac{1}{2}$ in. high and $4\frac{1}{4}$ in. deep. The net weight is $7\frac{1}{2}$ lb.

Square D A.C. and D.C. Starters

TWO STARTERS for a.c. and. d.c. service, respectively, have been placed on the market by the Industrial Controller Division of the Square D Company, Milwaukee, Wis. These starters are designated as the Class 8531 a.c. two-pole and the Class 8731 d.c. two-pole switches for across-the-line starting of small motors. They have silver contact points, a floating contactor armature, and two-pole double break contacts. The overload relay is of the thermal time-limit type with an external reset button in the cover. Low-voltage release is provided with two-wire control and low-voltage protection with three-wire control.

These starters are made in the Type B-1 for two- or three-wire con-



trol and the Type C-1 for two-wire control with a three-point switch in the cover for manual, off, and automatic operation. The a.c. starter is for use with motors up to $1\frac{1}{2}$ hp. at 110 volts and up to 3 hp. at 220 volts. The d.c. starter is for use with motors up to 1 hp., 115 and 230 volts.

The width of the starter is $7\frac{3}{4}$ in., height, $6\frac{3}{4}$ in., and depth, $4\frac{1}{2}$ in.

Cutler-Hammer 3-Position Pilot Switch

MOTOR-DRIVEN PUMPS, compressors, and similar machines which are controlled by an automatic pilot device such as a float switch, pressure switch, and time clock, often require some means of starting and stopping the motor manually. For this purpose, Cutler-Hammer, Inc., 2 12th St., Milwaukee, Wis., has developed a three-position pilot switch, of which the operating lever can be placed in

Cutler-Hammer Three-Position Pilot Switch for manual control of motors

either the "automatic," "off" or "manual" positions. When turned to "automatic," the automatic pilot device is in the circuit and normal, automatic operation is obtained. Turning the lever to "manual" position closes the control circuit direct and the motor will run continuously regardless of any other control devices as long as voltage is on the line.

The construction is simple. It consists of a two-button, push-button switch inside the case, the buttons of which are operated by a cam attached to the operating lever. The lever will remain as placed in each position.

"Locomax" Front-End Paint, Locomotive

TWO MONTHS' SERVICE with one application can be obtained from "Locomax," a front-end paint for locomotives developed by the Koppers Research Corporation, Pittsburgh, Pa., and being marketed by the American Tar Products Company, Koppers Building, Pittsburgh, Pa. "Locomax" withstands intense heat and rapid changes in temperature without deterioration and without loss of protection to the metal covered. It can be applied on hot surfaces without danger of flashing back. It is a bituminous product that produces a satin-like finish similar to that produced by a graphite paint, and can be obtained in standard black and standard gray egg-shell finishes from jet black to a light steel gray.

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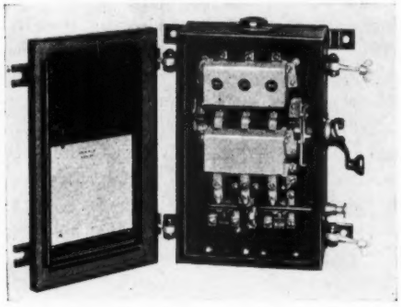
Square D Dust-Tight Inclosure for Automatic Starters

THE INDUSTRIAL Controller Division of the Square D Company, Milwaukee, Wis., has recently put on the market a dust-tight inclosure for across-the-line and combination starters. The illustration shows the Class 8532-S starter with such an inclosure, which has been developed principally for those applications where special protection must be had against excessive dust.

The cabinets are of heavy-gage steel with heavy strap-iron mounting

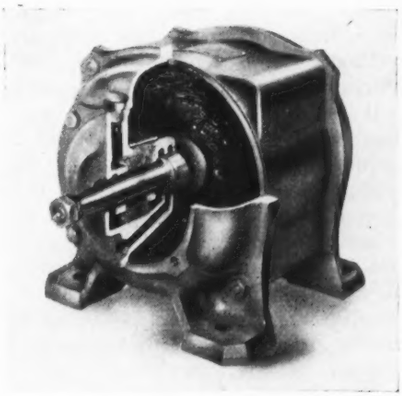


brackets. Cast-iron conduit flanges with live-rubber gaskets are furnished on the top and bottom of the cabinet to insure dust-tight conduit connections. As shown, the door has a deep flange for fitting around the cabinet. Inside the door is a heavy felt gasket fastened by means of metal strips and clamped against the wide cabinet flanges by means of hinged bolts. Two or more straps are provided on the door cover to receive the hinged bolts. For the thermal overload relays, a dust-tight push-button is furnished in the side of the cabinet.

Westinghouse Loom Motor

THREE essential features for loom service have been incorporated in the loom motor announced by the Westinghouse Electric & Manufacturing Company, East Pittsburgh, Pa. These features include high electrical efficiency, high power factor, and high overload capacity. Care has been taken in the design to incorporate an artistic and pleasing appearance, with the result that the motor blends in its outline with the loom that it drives.

Sustained overloads may be carried by this motor without damage. The



An unusually large chamber is provided for wool yarn lubrication in this Westinghouse Loom Motor

oiling arrangement is convenient and accessible. A snap lid on the oil cup prevents seepage, and an oil overflow is provided to conduct excess lubricant to a point outside the motor where it is instantly apparent. This feature also prevents excess oil from reaching the insulation. Wool yarn provides lubrication through a window in the bearing lining. Other features include a welded stator and rotor, a vibration-proof conduit fitting, moisture-proof insulation, and mounting arrangements for wall, floor, or ceiling operation.

Ames Dial Gage for Thin Materials

RAPID and accurate measurement of thin materials can be effected by the dial gage illustrated, which has been placed on the market by the B. C. Ames Company, Waltham, Mass. The dial reads to 0.000025 in., and closer measurements can be estimated.

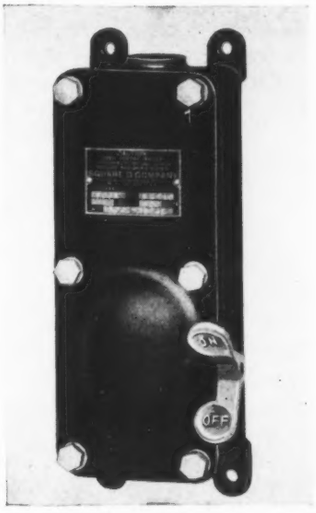
Any size of contact points can be furnished with the dial gage. The

jaws are opened by depressing the lower contact by means of the level, releasing it brings the lower contact up to a predetermined stop, which on material less than 0.002 in. thick gives a zero reading. On material of greater thickness than 0.002 in., the zero reading is obtained by inserting a standard between the contact points.

The gage is finished in black crystalline lacquer and all bright parts are chromium plated.

Square D Explosion-Proof Switch

A CAST-IRON housing with machined joints incloses the Class 9001, Type BR-10, explosion-proof control station announced by the Industrial Controller Division of the Square D Company, Milwaukee, Wis. The cast-iron housing is sufficiently



A sturdy cast-iron housing incloses the "Square D" Explosion-Proof Switch

strong to withstand internal explosions without transmitting the flame to the surrounding gaseous atmosphere. The inclosure is provided with two compartments, one of which is used for the contact mechanism and the other as a connection box. The contact mechanism consists of one normally open and one normally closed contact. Leads are sealed in a wall between these two compartments, and provision for conduit connection is made. Approval by the Underwriters has been obtained for this switch for locations where explosive mixtures of dust or gas may exist.

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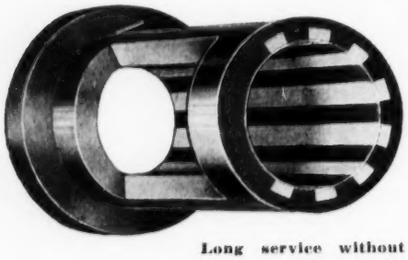
National Bimetallic Armature Bearings

REDUCTION in the amount of babbitt metal required is an advantage claimed for the bimetallic armature bearing developed by the National Bearing Metals Corporation, 230 Park Ave., New York City. In this bearing, eight slots have been cut in the bronze parallel to the axis of the armature shaft, thus giving a combination contact of bronze and lead-base babbitt metal. The bearing illustrated was designed for electric railway car journals, and 160,000 miles of service was obtained without serious wear during a test.



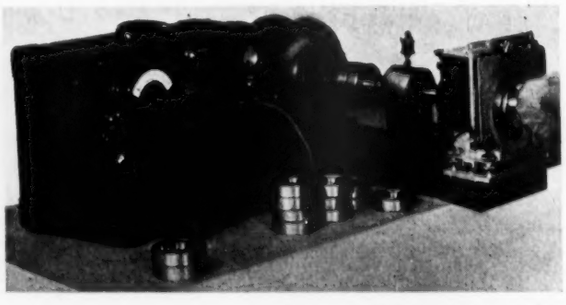
Long service without wear is afforded by the bimetallic design

Burgess Bearing Tester

TO PROVIDE an improved and scientific method for the testing and inspection of ball and roller bearings, both in the laboratory and in production, the Burgess Bearing Tester has been developed by the C. F. Burgess Laboratories, Inc. It is now being marketed by the Burgess-Parr Company, Room 1806, 111 W. Monroe St., Chicago. The Burgess bearing tester is one of a group of acoustimeters designed particularly to detect the amount of undesirable vibration in ball and roller bearings. These vibrations are transformed into electrical impulses, amplified so as to deflect the needle of an electrical meter. The extent of the deflection indicates the amount of undesirable vibration in the bearing under test. By means of electrical filters only those vibrations indicative of bearing quality are amplified, thus providing an accurate method of measurement and absolute independence of extraneous noises.

By means of this instrument bearings can be graded or sorted more definitely and accurately than by the method of listening to them. The time required for testing is not increased and great time savings are claimed because of the definite readings procured. According to the manufacturer, no time is lost in ascertaining the proper classification of "border-line" bearings.

The accuracy of this electrical method of inspection and test is claimed to be of even greater importance. Experiments have proved that the Burgess bearing tester repeats readings from day to day consistently, or from operator to operator. The instrument is sufficiently accurate to sort bearings into as many as five grades between excellent and defective.



Burgess Bearing Tester equipment is an acoustimeter type

"Ironite" Wear-Resistant Iron

THIS ALLOY IRON developed by the Kinite Corporation, 982 Wall St., Toledo, Ohio, is an electric furnace alloy in which chromium, nickel, and vanadium play an important part. The alloy is cast to shape and is claimed to reduce machining costs. It is intended for shorter production schedules, is lower in price than ordinary tool steels, and is used where initial costs are important in comparison with final costs such as in drawing and forming dies on short runs, for machine parts such as cams, gears, and machine bases, or any application where a rigid, wear-resisting metal of uniform structure is required. It is not applicable, however, for trimming, blanking, and cutting dies or for any tool to cut or shear.

An average heat of the material showed the castings to have a Brinell hardness of 235, a compression strength of 147,000 lb. per sq.in., and a tensile strength of 36,000 lb. per sq.in. Making certain changes in the analysis and in the pouring temperature, it is possible to obtain castings showing Brinell hardness ranging from 230 to 390, a tensile strength of from 35,000 lb. to 40,000 lb., and a compression strength of from 140,000 to 150,000 lb. per sq.in.

Harvel Protective Coating

Harvel, derived from a non-drying liquid of the Cashew nut, is now being marketed by the Harvel Division, Irvington Varnish & Insulator Company, Irvington, N. J. Samples of this material, after constant exposure to reagents such as deteriorate ordinary paints, varnishes, and enamels in less than 24 hours, are unaffected in periods from 30 to 90 days. Included in these reagents are acetic, citric, tannic, hydrochloric, lactic, phosphoric, and sulphuric acids, potassium hydroxide, sodium carbonate, sodium hydroxide, formaldehyde, sea water, Zonite, acetone, alcohol, chloroform, turpentine, and carbon bisulphide. After evaporation of its solvent, Harvel film solidifies mainly by chemical condensation associated with a slight degree of oxidation. Thus a solidified film of Harvel differs physically and chemically from the liquid form in which it is applied. Unlike paint or varnish its solidification is independent of external elements whose continued presence leads to disintegration. Unlike nitrocellulose lacquers, it is not again soluble in the elements that have evaporated from it. During application liquid Harvel is readily reduced to brushing or spraying consistency by means of turpentine or mineral turpentine substitutes. A solidified film, however, is insoluble in the same reducers, or in any of the common organic solvents. Harvel film is highly non-porous and is unusually hard and tough. Harvel coatings may be applied to metal, wood, or concrete surfaces and may be air dried or baked. They may be applied with brush or spray gun or by dipping. They dry to the touch in three hours and are completely dry in 12 hours. Pure Harvel liquid is of a reddish-brown mahogany color, with the general appearance and consistency of

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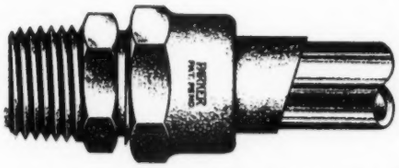
varnish. A number of colors are available when pigments are added. With the addition of oils to obtain penetrating quality, either with or without pigment, primers for cement and wood are produced. Basic pigments are ground with Harvel liquid to produce metal primer. Cement and wood primers are ground with pigments corresponding to the color desired for the top coats.

Parker Triple Tube Coupling

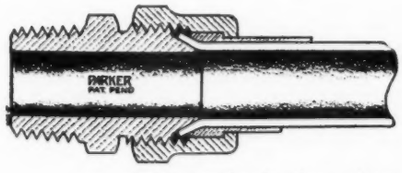
DESIGNED to retain all of the features characteristic of Parker standard tube couplings, and to meet installation conditions where entering the tube into the coupling body is inconvenient, a triple tube coupling is being produced by the Parker Appliance Company, 10320 Berea Road,



Exterior appearance of Parker Triple Tube coupling is conventional

Cleveland, Ohio. The new coupling does not displace the standard tube coupling but is used where installation conditions require its use in conjunction with the standard type.

Component parts of the triple coupling lock tightly when the nut is screwed on to the body, with extreme resistance to vibrational strain. Suit-



This sectional view shows the points of difference between this coupling and preceding ones

able flaring tools have been developed for the use on these tube couplings. Sleeves are faced angularly to reduce breakage of the tube at the outer end. Prices are now quoted on standard brass and extra-heavy brass types and quotations on steel are submitted on specific requirements. The couplings will be quoted ultimately in nickel alloy and Duralumin also.

"Bethalon" Chromium-Alloy Steel

A NON-CORROSIVE chromium-alloy steel is being produced by the Bethlehem Steel Company, Inc., Bethlehem, Pa., which has a yield point of 57,000 lb. per sq.in., a tensile strength of 90,000 lb. per sq.in., and a Brinell hardness of 174. When fully heat-treated, this alloy has a yield point of 158,000 lb. per sq.in., a tensile strength of 174,000, and a Brinell hardness of 352.

This alloy can be mechanically worked, either hot or cold. Ordinary forgings may be cooled in still air, since the metal does not air harden appreciably. Such operations as turning, drilling, threading, tapping, and parting are accomplished without any change in practice over that used for ordinary screw stock. Heading operations are performed on cold-drawn bars, after which it is not necessary to anneal the articles in assurance of good machining properties. The articles in question are drilled and tapped without difficulty. Bright finished wire has been drawn from $\frac{1}{4}$-in. round rods down to 0.020 in., and there is every indication that no hindrance will be encountered in production of finer sizes.

At the present time this steel is manufactured in the following forms: Annealed bars, within bar-mill sizes; ground bars, $\frac{1}{4}$ in. to 4 in. round; cold drawn rods; heat-treated bars; forging billets; drop forgings; press forgings and wire rods.

Q-Seal Joint Sealing Compound

A PLASTIC expansive joint sealing compound for railroad and industrial uses is offered by the Quigley Furnace Specialties Company, Inc., 56 W. 45th St., New York. The pigment of the compound expands and is carried in a vehicle that also expands through use of a newly discovered micaceous mineral which expands several times its own volume when subjected to heat. From this mineral, a natural lubricant and preserver of metal, the basic pigment used in "Q-Seal" is compounded. The vehicle used is impervious to steam, gas, gasoline, kerosene, oils, acids, ammonia, brine, vapor, creosote, tar, air and similar harmful materials which might cause injury to such a compound. Due to its expansive features, the compound fills any imperfections in gaskets, threads, or metallic surfaces in fabricating joints of all descriptions. It prevents corrosion or oxidation and still the joints may be broken with ease, regardless of age or the conditions to which they have been subjected.

The compound withstands high pressures and temperatures, remains plastic, and is unaffected by vibration. With its use defective or second-hand fittings and broken or burned gaskets may be used. It does not discolor any material conveyed in pipe lines, and it is highly resistant to heat and does not spoil.

It is applied with a brush at a consistency of cream under ordinary conditions. Gaskets may be dipped. Ordinary hemp packing soaked in the compound is ideal for packing pumps which handle steam, hot oils, and various acids. It is available in air-tight tins in the following sizes: 8 oz., 1 lb., 5 lb., and in air-tight metal containers of 10, 50, and 100 lb., also in steel drums. The material is thinned with water.

"Agate" Gloss Black Lacquer

A ONE-COAT high-gloss black lacquer, extremely high in luster and durability, is being produced by the Agate Lacquer Manufacturing Company, Inc., 11-13 43rd Road, Long Island City, N. Y. The lacquer is capable of application on all metals, including brass, copper, and iron. It is marketed in addition to the buffing lacquer which the company produces.

PATENTS

Frank L. Sessions, Lakewood, Ohio, has been granted patent 1,732,383 on a method of welding open butt-seams by pressing the terminals of an electric welding circuit upon each side of the seam and causing progressive relative traversing movement of said terminals parallel to the seam.
0.4 per cent carbon.

A grinding wheel slide and adjusting mechanism is disclosed by patent 1,734,-080 assigned to the Greenfield Tap & Die Corporation. This device has an axial adjustment of the wheel slide and a locking device for holding it in place.

Albert F. Shore, New York, N. Y., was granted patent 1,734,183 for a

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micrometer dial gage with an adjustable auxiliary pointer.

Wilson Rings Co. is the assignee of patent 1,734,188 disclosing a means for keying shafts to hubs by the use of a flexible key that is held under compression.

The method of making composition articles, which consists in mixing a quantity of fibrous material and an emulsion consisting of an organic binder and water, cold-molding said mixture under pressure into articles of the desired shape, and then subjecting the articles to prolonged heat-treatment for curing, is the subject of patent 1,732,478, assigned to Cutler-Hammer, Incorporated.

Arthur W. Caps, Rochester, N. Y., has assigned patent 1,771,994 to the Photostat Corporation, on a non-corrosible bearing combining a base member having an attaching wall and an outstanding supporting flange thereon, a ball race being supported on the flange, and a cover plate forming a lubricant chamber.

A trolley conveyor employing a suspension device having a spider comprising a series of spokes held by dogs and disengaged on contact with a cross support of the track is covered by patent 1,772,005 granted to George L. Hoxie, Oakland, Calif., and assigned to F. B. Fernhoff.

A shaft having a curve bottom key seat, a convex key, a straight key seat in the hub and a jamb screw engaging with one end of the key and forcibly securing the hub on the shaft is covered by patent 1,772,008 assigned by Walter F. Kasper, Fairmont, Minn., to the Fairmont Railway Motors, Incorporated.

Edward D. Bieretz and John J. Neal, Baltimore, Md., have been issued patent 1,772,029 on a semi-automatic gear-engiging transmission having co-axially driving and driven shafts, axially slidable member having internal spiral teeth and external teeth on the driven shaft, and devices for sliding the member in and out of engagement with either set of shaft teeth.

PUBLICATIONS

FOR THE DESIGNER'S LIBRARY

AUTOMATIC CONTROL. Ryan, Scully & Co., Philadelphia, Pa. A bulletin entitled "Automatic Control" deals with automatic combustion and temperature control equipment, including the different types of valve groupings and auxiliary equipment now available.

BOLTS AND NUTS. The Dardelet Threadlock Corporation, 120 Broadway, New York, N. Y., has issued a booklet "Dardelet Threaded Bolts and Nuts," citing their advantages for rail joints, crossing frogs, rigid turnout frogs, spring turnout frogs, and guard rails. The features of the Dardelet system are also explained.

FATIGUE STRENGTH OF METALS. The University of Illinois, engineering experiment station, has published bulletin No. 205, entitled "A Study of the Ikeda Short-Time (Electrical Resistance) Test for Fatigue Strength of Metals."

DIE CASTING. The Milwaukee Die Casting Co., 291-299 Fourth St., Milwaukee, Wis. This new booklet "What the Manufacturer Should Know About Die Casting" which carries a number of short articles on various phases of the design, production, and use of die castings. The book is illustrated with typical die castings and die-casting methods.

FINISHES. The Norfolk Paint & Varnish Co., Norfolk Downs, Mass., has just gotten out a catalog entitled "Norfolk Industrial, Technical, and Architectural Finishes" which describes the finishing products manufactured.

FLEXIBLE COUPLINGS. The Westinghouse Electric & Manufacturing Co., East Pittsburgh, Pa.—Two publications pertaining to mechanical power transmission equipment for general industrial use. Circular 1887 deals with complete descriptions of Westinghouse-Nuttall flexible couplings and circular 1891 deals with Westinghouse-Nuttall speed reducers of Types SVR, DVR and DVRA. Full information about application, construction, ratings, and dimensions of these units are included.

GASKET AND PACKING. The Goetze Gasket & Packing Co. Inc., New Brunswick, N. J., has just issued a 1930 catalog which shows scenes in the plant of the company, together with a list of the various types and sizes of gaskets made, including all types of both soft and hard packings.

GENERAL ELECTRIC PUBLICATIONS. The General Electric Co., Schenectady, N. Y., has issued a series of bulletins as follows: GEA-579A, superseding GEA-579, on "Automatic Full-Voltage Controllers for Synchronous Motors" in low voltage and high voltage series; GEA-708A, superseding GEA-708, on "General Purpose Synchronous Motors, '7600 Series' "; No. GEA-754A on "Semi-Automatic Reduced-Voltage Starters for Synchronous Motors" in high and low voltage series; GEA-1052-A, superseding GEA-1052, on "General-Purpose Synchronous Motors, '7500 Series' "; GEA-1201 on "Herringbone Gears"; GEA-1262 on "CR 9504 Operators," or hydraulic rams; GEA-"Thermostat for Industrial Heating Units" and GEA-1266 on the type "CR-7505-A1 Photo-Electric Relay."

INDUSTRIAL LUBRICATION. The Bowen Products Corporation, Auburn, N. Y. A bulletin entitled "Bowen Industrial Lubricating Systems," known as Catalog No. AF-72, describes the various systems of lubrication produced by this company and the method of application to standard units.

METALS UNDER REPEATED STRESS. The University of Illinois, Engineering Experiment Station, Urbana, Ill., has issued bulletin No. 208 entitled "A Study of Slip Lines, Strain Lines, and Cracks in Metals Under Repeated Stress," by Herbert F. Moore and Tibor Ver.

MOTORS. Reliance Electric & Engineering Co., Cleveland, Ohio, has issued Bulletin No. 107 on its fully inclosed, fan-cooled induction motors, Type AA, Form F, with ball bearings, for two- and three-phase a.c. circuits.

MOTORS. The Master Electric Co., Dayton, Ohio, has issued a booklet entitled "Your Guarantee for More and Better Master Motors" which describes the facilities of this company for serving buyers of its motors. Photographs of the various departments, the engineering divisions, the officers of the company, and the various products are included.

PROTECTIVE COATINGS. The Irvington Varnish & Insulator Company, Irvington, N. J. This company's booklet entitled "The Story of Harvel, the New Protective Coating" describes the product, and gives a series of illustrations of typical uses.

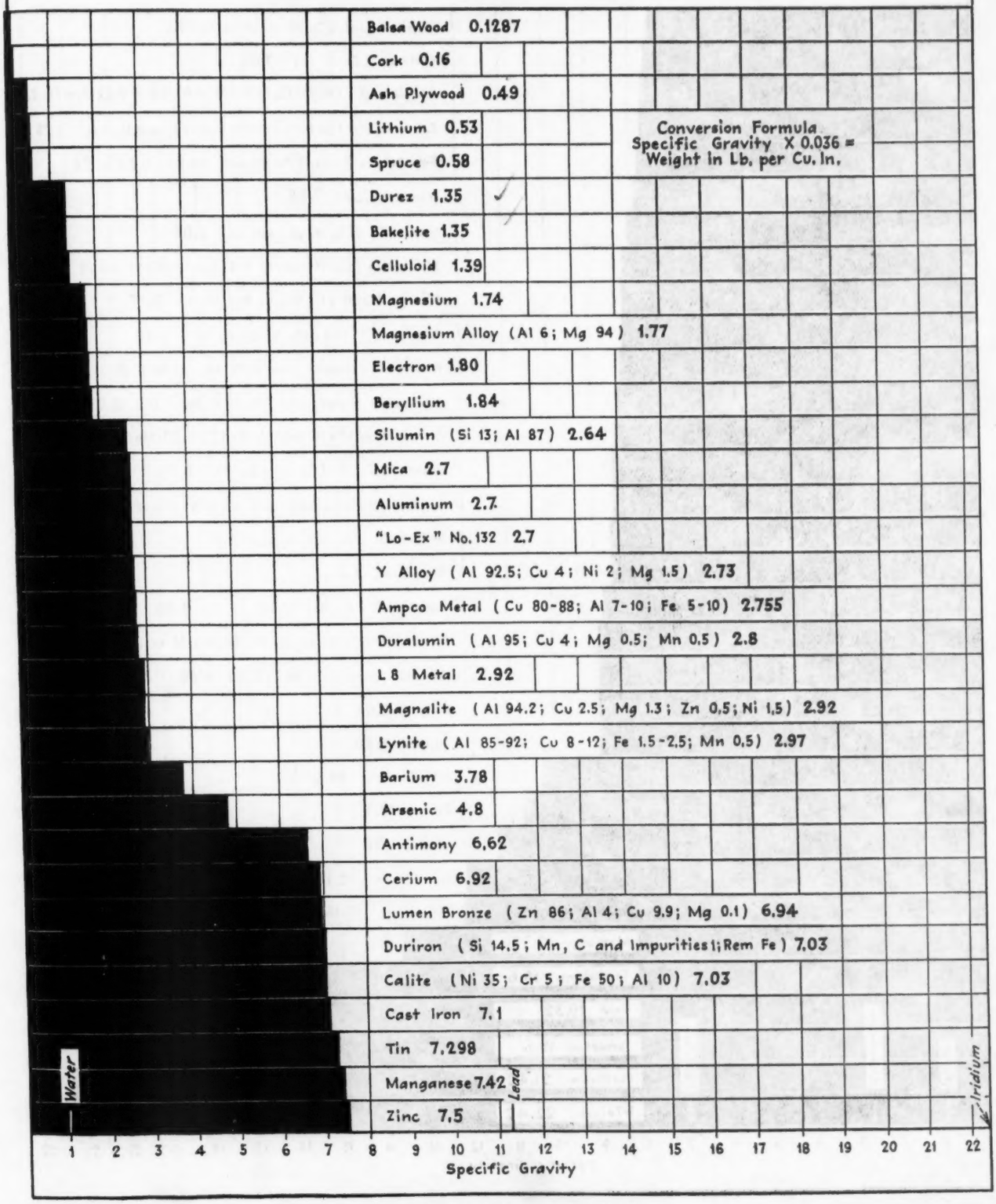
ROLLER BEARINGS. The Hyatt Roller Bearing Co., Harrison, N. J. Bulletin Q, entitled "The Application of Hyatt Roller Bearings to Pulp and Paper Machinery," is planned as an addition to the Hyatt data file. Sectional sketches of applications of Hyatt bearings to various types of pulp and paper machinery, together with illustrations, are included.

RUBBER, HARD. The American Hard Rubber Co., 11 Mercer St., New York, N. Y., has issued a booklet "Ace Hard Rubber Protection for Chemical Process Industries," which contains much information on the application of hard rubber under trying corrosive conditions.

SCIENTIFIC AND TECHNICAL ABSTRACTS. The Massachusetts Institute of Technology has published Nos. 5 and 6 of its "Abstracts of Scientific and Technical Publications" including abstracts of Doctors' Theses.

SCREWS. The Holo-Krome Screw Corporation, Hartford, Conn., announces a folder on "Holo-Krome" products such as setscrews, pipe plugs, and hollow-head capscrews, giving a list of the sizes manufactured and prices.

Material Weight Comparisons


Balsa Wood 0.1287
Cork 0.16
Ash Plywood 0.49
Lithium 0.53
Spruce 0.58
Durez 1.35
Bakelite 1.35
Celluloid 1.39
Magnesium 1.74
Magnesium Alloy (Al 6; Mg 94) 1.77
Electron 1.80
Beryllium 1.84
Silumin (Si 13; Al 87) 2.64
Mica 2.7
Aluminum 2.7
"Lo-Ex" No. 132 2.7
Y Alloy (Al 92.5; Cu 4; Ni 2; Mg 1.5) 2.73
Ampco Metal (Cu 80-88; Al 7-10; Fe 5-10) 2.755
Duralumin (Al 95; Cu 4; Mg 0.5; Mn 0.5) 2.8
L 8 Metal 2.92
Magnalite (Al 94.2; Cu 2.5; Mg 1.3; Zn 0.5; Ni 1.5) 2.92
Lynite (Al 85-92; Cu 8-12; Fe 1.5-2.5; Mn 0.5) 2.97
Barium 3.78
Arsenic 4.8
Antimony 6.62
Cerium 6.92
Lumen Bronze (Zn 86; Al 4; Cu 9.9; Mg 0.1) 6.94
Duriron (Si 14.5; Mn, C and Impurities 1; Rem Fe) 7.03
Calite (Ni 35; Cr 5; Fe 50; Al 10) 7.03
Cast Iron 7.1
Tin 7.298
Manganese 7.42
Zinc 7.5
Conversion Formula
Specific Gravity X 0.036 = Weight in Lb. per Cu. In.
Water
Lead
Iridium
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Specific Gravity

No. 2 — *REFERENCE-BOOK SHEET* — Materials

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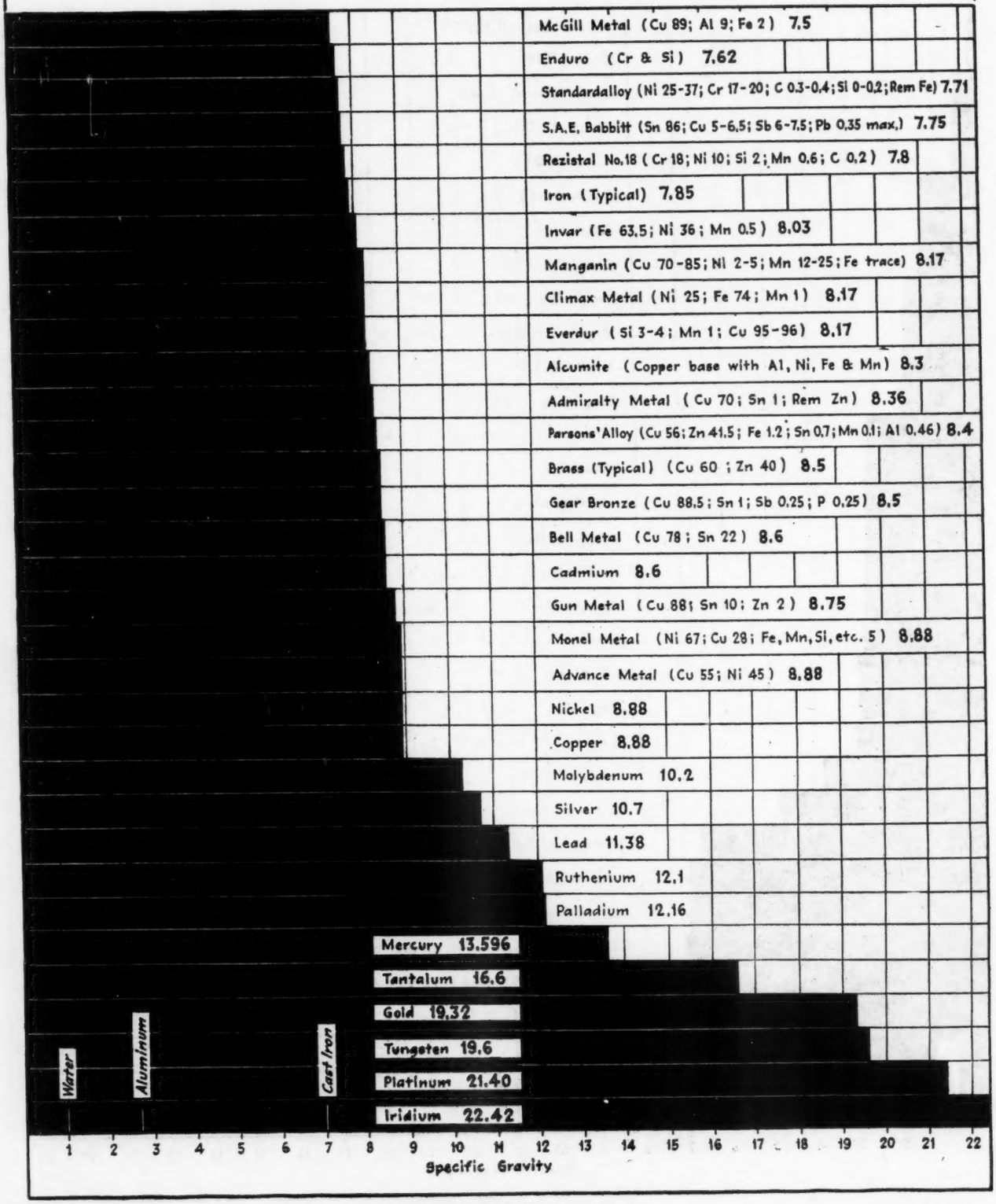
Material Weight Comparisons


McGill Metal (Cu 89; Al 9; Fe 2) 7.5
Enduro (Cr & Si) 7.62
Standardalloy (Ni 25-37; Cr 17-20; C 0.3-0.4; Si 0-0.2; Rem Fe) 7.71
S.A.E. Babbitt (Sn 86; Cu 5-6.5; Sb 6-7.5; Pb 0.35 max.) 7.75
Rezistal No.18 (Cr 18; Ni 10; Si 2; Mn 0.6; C 0.2) 7.8
Iron (Typical) 7.85
Invar (Fe 63.5; Ni 36; Mn 0.5) 8.03
Manganin (Cu 70-85; Ni 2-5; Mn 12-25; Fe trace) 8.17
Climax Metal (Ni 25; Fe 74; Mn 1) 8.17
Everdur (Si 3-4; Mn 1; Cu 95-96) 8.17
Alcumite (Copper base with Al, Ni, Fe & Mn) 8.3
Admiralty Metal (Cu 70; Sn 1; Rem Zn) 8.36
Parsons' Alloy (Cu 56; Zn 41.5; Fe 1.2; Sn 0.7; Mn 0.1; Al 0.46) 8.4
Brass (Typical) (Cu 60; Zn 40) 8.5
Gear Bronze (Cu 88.5; Sn 1; Sb 0.25; P 0.25) 8.5
Bell Metal (Cu 78; Sn 22) 8.6
Cadmium 8.6
Gun Metal (Cu 88; Sn 10; Zn 2) 8.75
Monel Metal (Ni 67; Cu 28; Fe, Mn, Si, etc. 5) 8.88
Advance Metal (Cu 55; Ni 45) 8.88
Nickel 8.88
Copper 8.88
Molybdenum 10.2
Silver 10.7
Lead 11.38
Ruthenium 12.1
Palladium 12.16
Mercury 13.596
Tantalum 16.6
Gold 19.32
Tungsten 19.6
Platinum 21.40
Iridium 22.42
Water
Aluminum
Cast Iron
1 2 3 4 5 6 7 8 9 10 11 12 13 14 15 16 17 18 19 20 21 22
Specific Gravity

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